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ABSTRACT

This 1981 guide is designed to be used with a workbook offering students opportunities to engage in creative problem solving. The book contains four units with 23 lessons. Unit 1 addresses problem solving and contains nine lessons: (1) "New and Different Thinking"; (2) "Open and Closed Problems"; (3) "Stating a Problem"; (4) "Defining a Problem"; (5) "Brainstorming"; (6) "Groups"; (7) "Thinking of Ideas"; (8) "Judging Ideas"; and (9) "Seesaw." Unit 2 introduces futures studies and includes the lessons: (10) "Futures Studies"; (11) "Forecasting the Future"; (12) "Accelerating Trends"; (13) "Constructing Forecasts with a Cross-Impact Matrix"; and (14) "Food and People." Unit 3 teaches an addition problem-solving process and has the lessons: (15) "Introduction to Analogies"; (16) "Personal Analogies"; (17) "Key Words and Clash Statements"; (18) "Analogy Excursions"; (19) "The Windmill Problem"; and (20) "Project Vista." Unit 4 concentrates on two methods for specifying consequences and exploring alternative futures and includes: (21) "Using Future Wheels To Construct Forecasts"; (22) "Using Scenarios To Construct Forecasts"; and (23) "Life in Vista." The reference section contains a discussion about students in groups, techniques for generating ideas, a description of future studies, and a 149-item bibliography. (EH)

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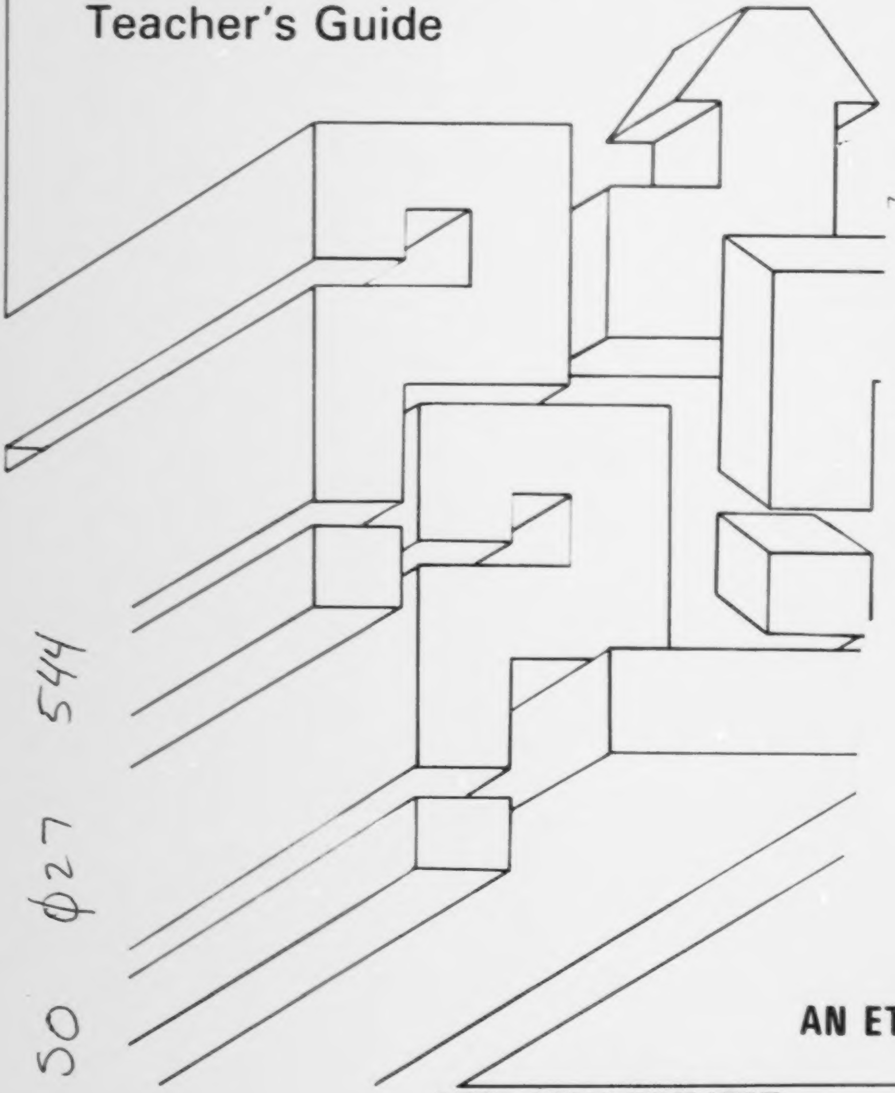
MAKING CHANGES

a futures-oriented course in inventive problem solving

Teacher's Guide



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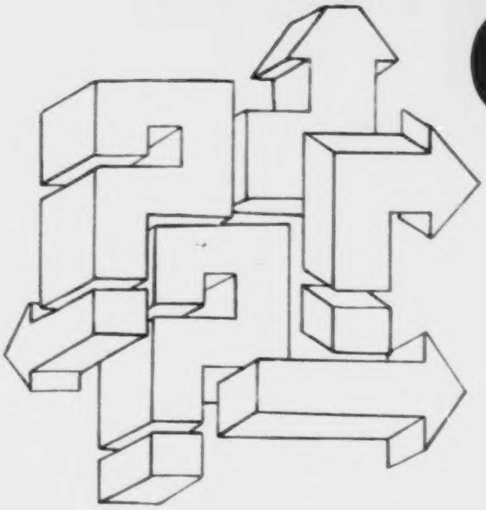
MAKING CHANGES



A FUTURES-ORIENTED COURSE
in
INVENTIVE PROBLEM SOLVING

Developed by John W. Thomas

Teacher's Guide

866 a/o

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The Teacher's Guide to the *Making Changes* program is a product of an intensive two-year development effort. This guide as well as the other components of the program have been through three major revisions as a direct result of content reviews, classroom tryouts, a pilot test and a field test. The fact that so much was done by so few in such a short time requires that the following people be acknowledged for facilitating the development process.

Although the *Making Changes* materials have been administered and tested at eight sites, the teachers and principal at Clifton Heights Junior High School in Upper Darby, Pennsylvania deserve special recognition for their time and advice, especially Harrington Bell, III, language arts coordinator.

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INTRODUCTION

OVERVIEW

Making Changes is four courses in one.

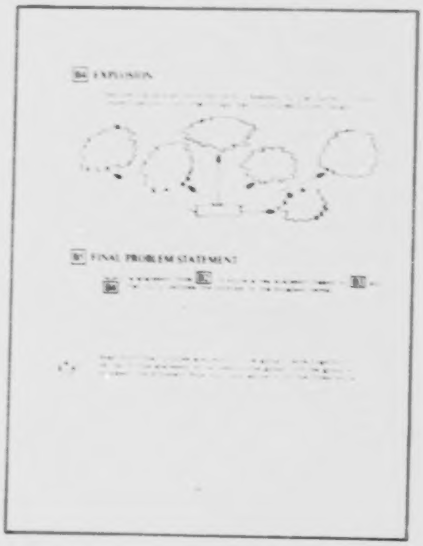
Making Changes is designed to teach skills and strategies of: (1) problem solving, (2) inventing, (3) futuring, and (4) working in groups.

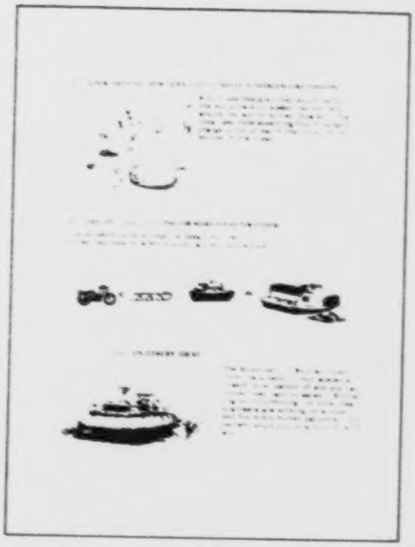
1. Problem solving

How to recognize, define and go about solving open-ended problems.

> *Skills of thinking can be trained. There are skills of becoming aware of a problem, of formulating the problem, of organizing the necessary evidence, of generating many ideas, and of judging the quality of the solution. Each of these skills can be cultivated through specific procedures, and each is enhanced by regular exercise. Productive thinking is a complex process which must be an educational end in itself — it is not the automatic result of other kinds of learning.*

— Louis Rubin
Life Skills in School and Society, NEA





2. Inventing

How to use a set of techniques to become more fluent, flexible, and original in generating ideas.

> *The most direct way to develop creativity is by practicing creativity — by actually thinking up solutions to specific problems.*

— Alex F. Osborn
Applied Imagination

> *With the exception of the individual who is manifestly creative, all persons may benefit from exposure to and/or participation in individual or group techniques for stimulating creativity.*

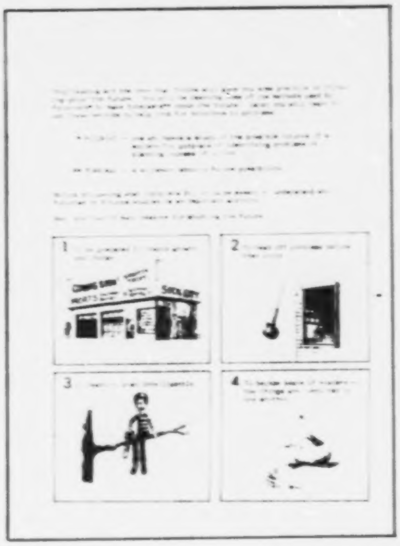
— Morris I. Stein
Stimulating Creativity, Vol. 2

3. Futuring

How to use techniques of forecasting to define and solve future-oriented problems.

What we can and must do is give students an understanding of the most important issues, problems, and opportunities they may face; teach them the skills they will need to continue to look ahead on their own; and prepare them to cope successfully with the dislocations and stresses of rapid change.

—Draper L. Kauffman
Teaching the Future



4. Working in groups

How to encourage and maintain productive group effort.

Modern life, particularly in the cities, places a premium on the ability to relate well with others, and future adults will be compelled to deal with conflicts... to handle them constructively and creatively if some of the social problems of the world are to be solved.

—Richard A. Schmuck and
Patricia A. Schmuck
Group Processes in the Classroom

COURSE DESCRIPTION

Target Population

Students in grades 7-10.

Course Length

32 to 50 periods of 45 minutes.

Materials

Teacher's guide, student lesson book, transparencies, and handouts.

Program Organization

Unit I

The first unit is addressed to problem solving. A multi-stage model is introduced for proceeding from "a mess" -- a complaint or difficulty -- to the selection of a solution idea according to established criteria. Several techniques and strategies are taught in Unit One with most emphasis placed on techniques for defining problems and for generating ideas. Unit One is loosely modeled after a number of programs and courses offered in universities and industrial settings under the heading of creative problem solving or creative design. Unit One also introduces some of the group rules and roles that influence subsequent activities. The unit culminates in a two to three hour guided problem-solving experience designed to provide for practice on all the cognitive as well as group skills covered.

Unit II

The second unit is an introduction to futures studies. Beginning with readings on the assumptions of futurists, students learn about techniques for forecasting, such as the Delphi method and the extension of trends. Students learn to interpret and evaluate forecasts, trends, and their interaction and consequences in preparation for a "problem-finding" activity on the subject of the future of food. Unit II also teaches an analytical technique that has special importance for problem-solving tasks to come, namely, the cross-impact matrix.

Unit III

The third unit teaches an additional problem-solving process that is especially useful for discovering new ways of doing things. The process is called an analogy excursion and involves looking for analogies from nature, acting out personal analogies and other aids for the imagination. Students solve design problems and complete plans for energy-efficient homes for the year 2005 in the final lesson of this unit.

Unit IV

The final unit concentrates on two methods for specifying consequences and for exploring alternative futures — the scenario and the future wheel. The unit ends with a week-long simulation involving the consequences and interrelationships of technological developments. Small groups of students, acting in the role of advocate groups, compete for the approval of their proposals.

OBJECTIVES

Objectives for the *Making Changes* program are drawn from both the cognitive and the affective domain. The following is only a partial listing.

Knowledge

- stages of problem solving
- assumptions of futurists
- group roles

Skills

- analyzing a problem into its parts
- weighting criteria and evaluating solution ideas
- judging the reliability of forecasts

Strategies

- using the *checkerboard* and *checklist* to generate ideas
- constructing a *future wheel* to generate consequences
- testing an idea by writing a *scenario*

Attitudes

- increased tolerance of ambiguity
- confidence in one's power to influence the future
- appreciation of others' ideas

Dispositions

- autonomous use of problem-solving strategies
- better fit between personal and societal forecasts
- perseverance in problem-solving tasks

Making Changes is unique in that its central objectives are not linked to a particular content. The program has been developed to teach a set of generalizable cognitive strategies. These strategies — techniques, rules of thumb — can be used on any open-ended problem. Although there is no guarantee that the use of these strategies will result in the "best" or most creative solution, research has shown that their use should increase the range of possible solutions considered.

RATIONALE

Among the premises that served to initiate and guide the development of the *Making Changes* course are the following:

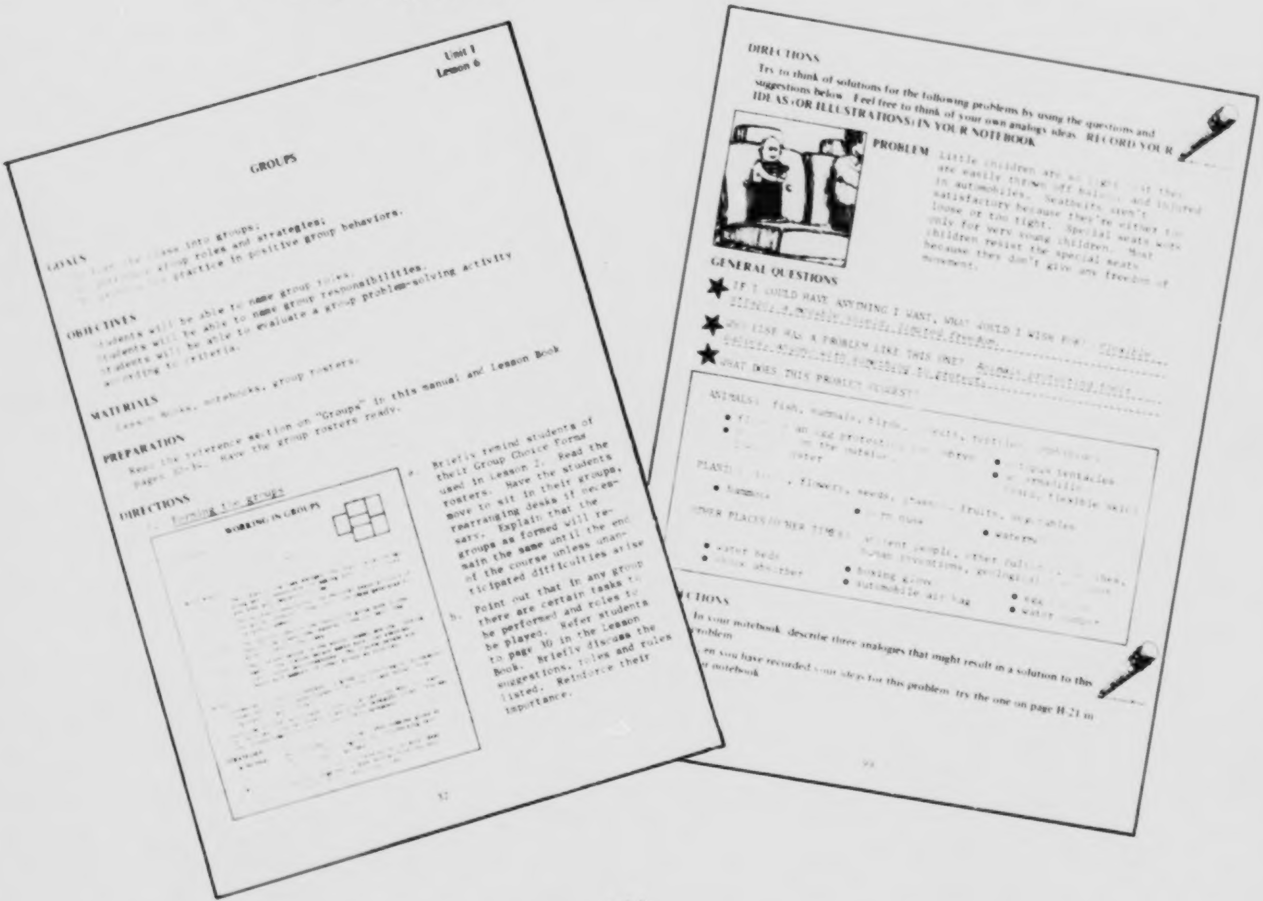
- Schools have a responsibility to teach "essential life skills" — skills defined through an analysis of the demands of the out-of-school world.
- Skills for dealing with problems that have no right answer and no set method of attack represent an important aspect of these essential life skills.
- The utility of skills for planning, for defining problems, for evaluating forecasts, etc. is likely to increase rather than decrease in the future.
- Such skills are not likely to develop if left to chance.
- These skills are sufficiently important to deserve direct intervention and to become an independent aspect of the curriculum.
- The most productive method of intervention is to imbed instruction in these skills within the context of meaningful and provocative problem-solving ventures and simulations.
- As important as skill training is, it is insufficient for a meaningful course in problem solving. The course must attempt to make pervasive changes in students' attitudes, beliefs, and dispositions.
- In order for learned skills to be used in an autonomous and productive fashion, students must be confident that they have some power to affect their future.
- The best way to build that confidence is to construct situations wherein all students have the opportunity to use their imagination and to suggest changes and where students' ideas are rewarded by their peers and by their teachers.

Accordingly, a program like *Making Changes* cannot exist without the cooperation, wisdom, and guidance of a teacher. Inventive problem solving cannot be imparted through programmed instruction alone. It is a process that must be shaped by a creative teacher and encouraged by a receptive environment.

THE MATERIALS

The following materials are included with the *Making Changes* program:

1. *Teacher's Guide.* The teacher's guide includes:
   - introduction
   - suggested schedule
   - lesson summary pages with time estimates
   - homework summary pages
   - day-by-day lesson descriptions
   - transparencies
   - reference section
   - list of references
2. *Student Lesson Book.* The Lesson Book is a non-consumable booklet divided into four sections, one for each of the four units. The Lesson Book contains the major portion of the concepts and strategies that make up the program's objectives as well as the exercises and homework assignments that provide practice on these objectives.



Unit 1
Lesson 6

GROUPS

GOALS

[illegible] the class into groups;
[illegible] group roles and strategies;
[illegible] practice in positive group behaviors.

OBJECTIVES

Students will be able to name group roles.
Students will be able to name group responsibilities.
Students will be able to evaluate a group problem-solving activity according to criteria.

MATERIALS

Lesson Books, notebooks, group rosters.

PREPARATION

Read the reference section on "Groups" in this manual and Lesson Book pages 33-34. Have the group rosters ready.

DIRECTIONS

1. Forming the groups

WORKING IN GROUPS

a. Briefly remind students of their Group Choice Forms used in Lesson 2. Read the rosters. Have the students move to sit in their groups, rearranging desks if necessary. Explain that the groups as formed will remain the same until the end of the course unless unanticipated difficulties arise.

b. Point out that in any group there are certain tasks to be performed and roles to be played. Refer students to page 30 in the Lesson Book. Briefly discuss the suggestions, roles and rules listed. Reinforce their importance.

32

DIRECTIONS

Try to think of solutions for the following problems by using the questions and suggestions below. Feel free to think of your own analogy ideas. RECORD YOUR IDEAS (OR ILLUSTRATIONS) IN YOUR NOTEBOOK.

PROBLEM Little children are so light that they are easily thrown off balance and injured in automobiles. Seatbelts aren't satisfactory because they're either too loose or too tight. Special seats work only for very young children. Most children resist the special seats because they don't give any freedom of movement.

GENERAL QUESTIONS

★ IF I COULD HAVE ANYTHING I WANT, WHAT WOULD I WISH FOR? [illegible]
★ WHO ELSE HAS A PROBLEM LIKE THIS ONE? [illegible]
★ WHAT DOES THIS PROBLEM SUGGEST?

ANIMALS: fish, mammals, birds, [illegible]

PLANTS: [illegible] flowers, seeds, [illegible] fruits, vegetables

OTHER PLACES/OTHER TIMES: [illegible]

ACTIONS

In your notebook, describe three analogies that might result in a solution to this problem.

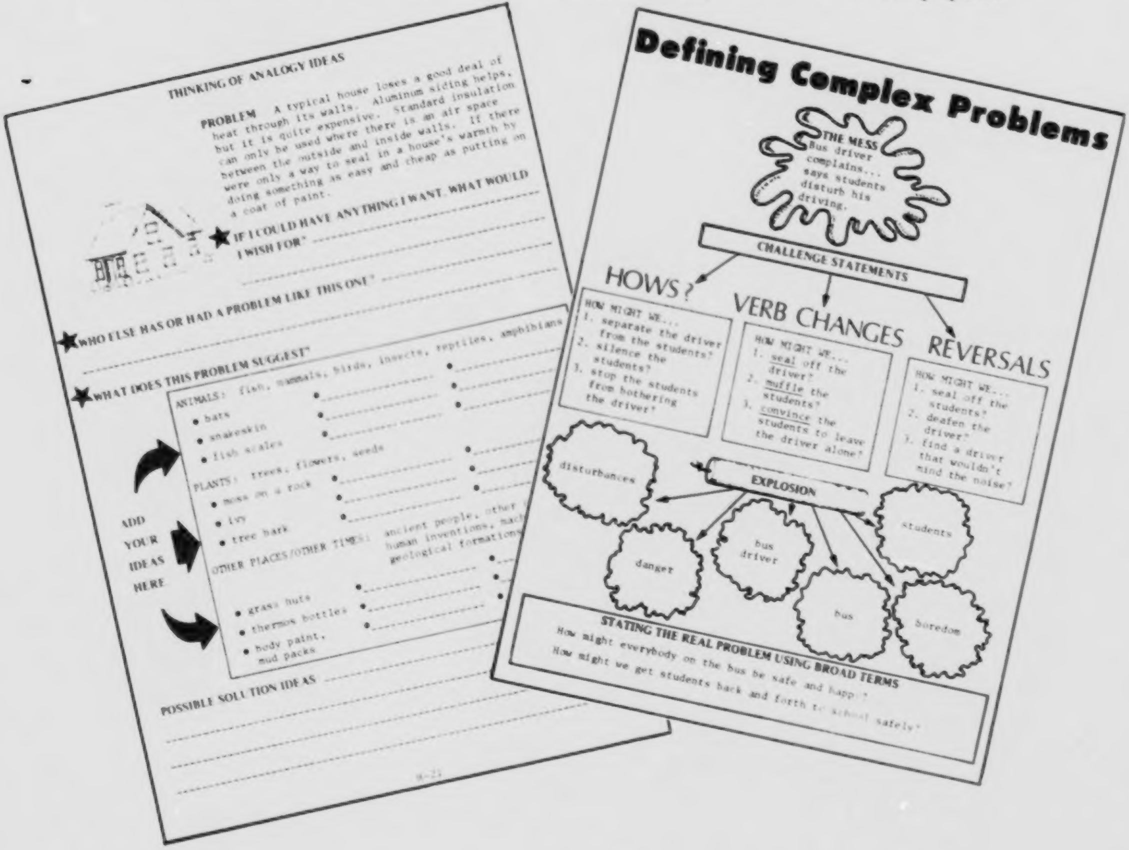
When you have recorded your ideas for this problem, try the one on page H-21 in your notebook.

3. *Handouts.* Handouts are consumable pages that present exercises and problems to be completed in class or as part of a homework assignment.

4. *Posters.* Three posters are included with the course. One illustrates the problem solving process and techniques taught in Unit I, another shows the analogy excursion process, and the third presents each of the techniques for exploring alternative futures.

5. *Test Packet.* The test packet includes a Mastery Test and a Proficiency Test for each unit, a Futures Orientation Survey and a Scenario measure as well as directions and scoring guides for each instrument.

Note: In addition to the materials described above, each student needs a three-ring notebook and approximately 50 sheets of paper.



THINKING OF ANALOGY IDEAS

PROBLEM A typical house loses a good deal of heat through its walls. Aluminum siding helps, but it is quite expensive. Standard insulation can only be used where there is an air space between the outside and inside walls. If there were only a way to seal in a house's warmth by doing something as easy and cheap as putting on a coat of paint.

★ IF I COULD HAVE ANYTHING I WANT, WHAT WOULD I WISH FOR?

★ WHO ELSE HAS OR HAD A PROBLEM LIKE THIS ONE?

★ WHAT DOES THIS PROBLEM SUGGEST?

ANIMALS: fish, mammals, birds, insects, reptiles, amphibians
- bats
- snakeskin
- fish scales

PLANTS: trees, flowers, seeds
- moss on a rock
- ivy
- tree bark

OTHER PLACES/OTHER TIMES: ancient people, other human inventions, mach geological formations
- grass huts
- thermos bottles
- body paint, mud packs

ADD YOUR IDEAS HERE

POSSIBLE SOLUTION IDEAS

Defining Complex Problems

THE MESS
Bus driver complains... says students disturb his driving.

CHALLENGE STATEMENTS

HOWS?

HOW MIGHT WE...
1. separate the driver from the students?
2. silence the students?
3. stop the students from bothering the driver?

VERB CHANGES

HOW MIGHT WE...
1. seal off the driver?
2. muffle the students?
3. convince the students to leave the driver alone?

REVERSALS

HOW MIGHT WE...
1. seal off the students?
2. deafen the driver?
3. find a driver that wouldn't mind the noise?

EXPLOSION

STATING THE REAL PROBLEM USING BROAD TERMS

How might everybody on the bus be safe and happy?
How might we get students back and forth to school safely?

ADMINISTRATION

The Place of *Making Changes* in the Curriculum

Making Changes has been designed to provide a supplementary course of instruction in problem solving and futures studies. The eclectic nature of its subject matter combined with its administrative flexibility make it possible to incorporate the course into the science, social studies or English program on a half-semester or full semester basis. *Making Changes* could also be spread out over a year's time or offered as an independent elective or mini-course.

Reading Level

According to a readability survey taken on the materials, the program is suitable for students reading at the seventh grade level and above. However, the sophistication of some of the concepts and issues introduced in the futures studies section as well as the length and complexity of many of the homework assignments, make the program most appropriate for mature students in grades eight through ten.

Using the Program

For a number of reasons, the *Making Changes* program is an unusual one. It is a program without a subject matter and without the "right answers" that students have come to expect. It is a program that combines frivolity with some of the most serious issues in the world today. Finally, it is a program that requires a certain amount of hard work from both teachers and students without a clear conception, at least at the beginning, of what the payoffs will be. The following suggestions submitted by teachers and observers during the course of a field test of the *Making Changes* program, seem to be useful for reducing the ambiguities and for insuring a successful administration.

Rules of Thumb

- **Embellishment** Most students become interested in problems and issues to the extent that these topics have relevance for their lives. Since the *Making Changes* materials were written to be equally applicable to urban seventh graders in the Northeast as to rural tenth graders in the West, there may well be a "relevancy gap" at different points in the program that could be bridged through the introduction of local problems and concerns.

- **Providing for application** Students have a tendency to view the strategies taught in the course as tied to the content areas they were introduced with and fail to see how these strategies are applicable to other problems. It is advisable to give students suggestions for how they might apply the strategies to their own lives.

- **Providing guidance and feedback** There is no provision in the program for giving the individualized guidance and corrective feedback that is so important for the learning of new skills. Correcting homework assignments, providing additional in-class exercises, circulating among the groups and requesting that students help each other with assignments are all methods that might facilitate the learning of *Making Changes* skills and strategies.

  Feedback is important in another sense as well. Students may be self-conscious at first about voicing their ideas. Praising students and groups for their solution ideas and maintaining an environment wherein criticism is replaced by praise and individual attention will do wonders for the effectiveness of the program.

- **Familiarization** The program is fairly easy to administer. Complete directions are included for all lessons, activities and homework reviews. Even so, a thorough preview is recommended for each lesson. To a great extent, students will be more committed to the program if they sense that their teacher is both familiar with and enthusiastic about each activity.

  Familiarization with the materials is also important in order to anticipate difficulties and time problems and in order to establish a schedule that is appropriate for a particular class.

Dilemmas

- **Group productivity** Establishing and maintaining productive small groups can be the key or the impediment to program effectiveness. From field trials of the program, it appears that groups that are based on friendship are more satisfactory to students but are not as productive in the long run as groups formed so that a mixture of interests and skills are ensured. The difficulty associated with breaking cliques, of course, is how to initiate a comfortable working relationship and how to get students to open up to one another. Activities designed to "break the ice," making groups responsible for both "task" and "maintenance" functions, and requiring a tangible output for each session are all remedies that might be employed throughout the administration of the program.

- **Laissez-faire vs. intervention** In many classrooms, the administration of *Making Changes* will pose an additional dilemma. Some students will be discouraged by the lack of correct answers; others will complain about the homework. Some students will misuse the freedom involved in some of the activities; others will rebel at using their imagination and insist on rules and deadlines. An effective administration seems to require patience and tolerance for ambiguity combined with a willingness to intervene in order to insure that each lesson is a learning activity.

- **Following the directions** The program has a good deal of structure to it. There are suggested times for lesson parts, specific directions for activities, even suggested feedback for students' responses to homework assignments. The manual was constructed in this fashion in order to be useful to as wide an audience as possible. An assumption that goes with this design is that most teachers will use the manual as a "consultant" and not as a "boss" and will always have definitive directions to fall back on when needed.

Scope and Sequence

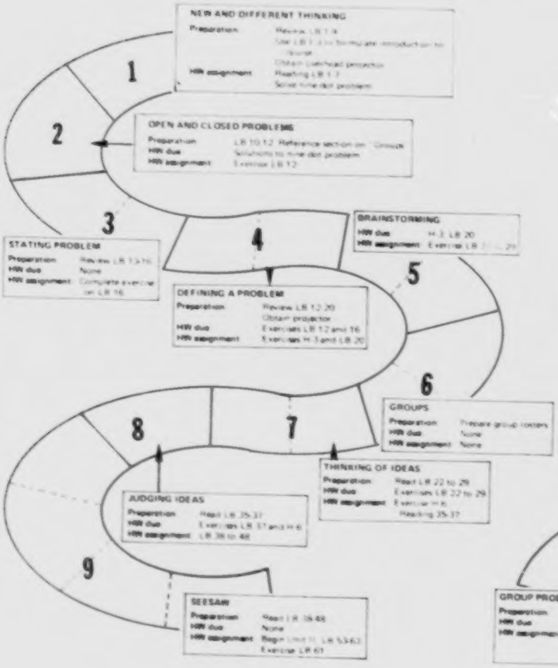
The units that make up the program and especially the lessons within each unit build upon one another in such a way that students are called upon to learn new skills while at the same time applying skills taught earlier in the course. At the end of each unit, and then in the culminating activity at the end of Unit IV, all previously learned skills are employed in concert. For these reasons, the omission of a lesson or unit may weaken the impact of the program. If it is not possible to administer the total program, a careful examination of the objectives and lessons as well as the tie-ins and dependencies among units is recommended.

- **Time per lesson** Unless otherwise noted, each lesson has been designed to fill 40 to 50 minutes of class time under ideal circumstances. Lesson Summary pages are included for each lesson in the program. These pages provide an estimate of the time required for each of the activities that make up the lesson. In most cases, the minimum time listed will add up to a typical class period of 45 minutes while the maximum times estimated for each of the activities may add up to two or more class periods. Lessons that require two or more class periods will be so noted on the Lesson Summary page and on the Unit Calendars that follow in this section.

- **Total administration time** Since the time required for individual lessons will vary acrosss different teachers and student populations, it is only possible to give an estimated range for the total time required for the course. Field trials* of the program revealed that the minimum time required to complete the course was 8 weeks, or 40 45-minute sessions. Most teachers elected to devote approximately 12-14 weeks to the program while others required as many as 16 weeks to complete all the lessons.

  Calendars for each of the units appear on the first page of the lesson description section for each unit and are reproduced on the following page.

CALENDAR AND HOMEWORK SUMMARY
UNIT I



NEW AND DIFFERENT THINKING

Preparation	Review LB 1-9 Use LB 1-3 to formulate introduction to course Obtain overhead projector
HW assignment	Reading LB 1-7 Solve nine-dot problem

OPEN AND CLOSED PROBLEMS

Preparation	LB 10-12. Reference section on "Groups"
HW due	Solutions to nine-dot problem
HW assignment	Exercise LB 12

STATING PROBLEM

Preparation	Review LB 13-16
HW due	None
HW assignment	Complete exercise on LB 16

BRAINSTORMING

HW due	H-3, LB 20
HW assignment	Exercise LB 22 to 29

DEFINING A PROBLEM

Preparation	Review LB 12-20 Obtain projector
HW due	Exercises LB 12 and 16
HW assignment	Exercises H-3 and LB 20

GROUPS

Preparation	Prepare group rosters
HW due	None
HW assignment	None

THINKING OF IDEAS

Preparation	Read LB 22 to 29
HW due	Exercises LB 22 to 29
HW assignment	Exercise H-6 Reading 35-37

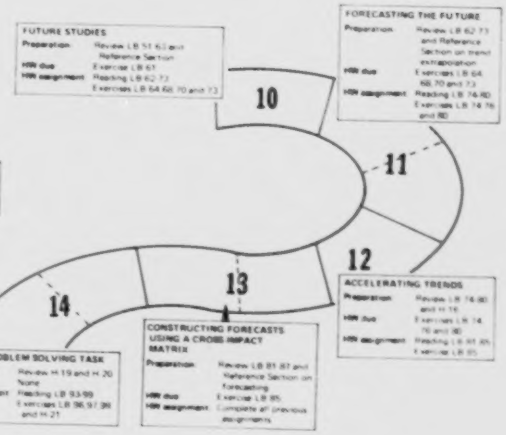
JUDGING IDEAS

Preparation	Read LB 35-37
HW due	Exercises LB 37 and H-6
HW assignment	LB 38 to 48

SEESAW

Preparation	Read LB 38-48
HW due	None
HW assignment	Begin Unit II, LB 53-63 Exercise LB 61

CALENDAR AND HOMEWORK SUMMARY
UNIT II



FUTURE STUDIES

Preparation	Review LB 51-63 and Reference Section
HW due	Exercise LB 61
HW assignment	Reading LB 62-73 Exercises LB 64, 68, 70 and 73

FORECASTING THE FUTURE

Preparation	Review LB 62-73 and Reference Section on trend extrapolation
HW due	Exercises LB 64, 68, 70 and 73
HW assignment	Reading LB 74-80 Exercises LB 74-76 and 80

ACCELERATING TRENDS

Preparation	Review LB 74-80 and H-16
HW due	Exercises LB 74-76 and 80
HW assignment	Reading LB 81-85 Exercise LB 85

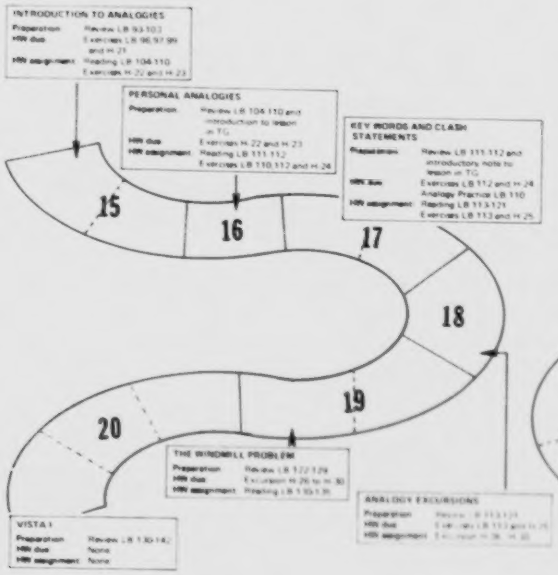
CONSTRUCTING FORECASTS USING A CROSS-IMPACT MATRIX

Preparation	Review LB 81-87 and Reference Section on forecasting
HW due	Exercise LB 85
HW assignment	Complete all previous assignments

GROUP PROBLEM SOLVING TASK

Preparation	Review H-19 and H-20
HW due	None
HW assignment	Reading LB 93-99 Exercises LB 96, 97, 98 and H-21

CALENDAR AND HOMEWORK SUMMARY
UNIT III



INTRODUCTION TO ANALOGIES

Preparation	Review LB 93-103
HW due	Exercises LB 96, 97, 99 and H-21
HW assignment	Reading LB 104-110 Exercises H-22 and H-23

PERSONAL ANALOGIES

Preparation	Review LB 104-110 and introduction to lesson in TG
HW due	Exercises H-22 and H-23
HW assignment	Reading LB 111-112 Exercises LB 110, 112 and H-24

KEY WORDS AND CLASH STATEMENTS

Preparation	Review LB 111-112 and introductory note to lesson in TG
HW due	Exercises LB 112 and H-24 Analogy Practice LB 110
HW assignment	Reading LB 113-121 Exercises LB 113 and H-25

ANALOGY EXCURSIONS

Preparation	Review LB 113-121
HW due	Exercises LB 113 and H-25
HW assignment	Excursion H-26 - H-30

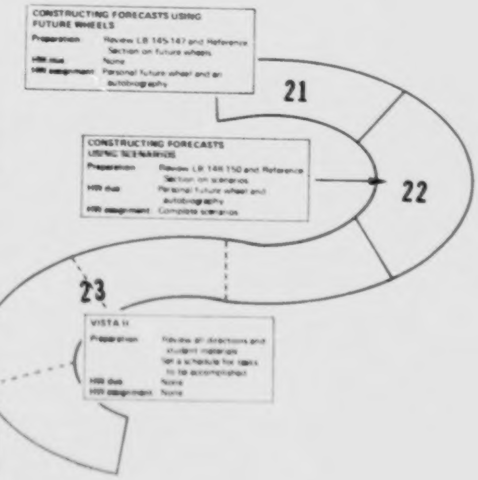
THE WINDMILL PROBLEM

Preparation	Review LB 122-129
HW due	Excursion H-26 to H-30
HW assignment	Reading LB 130-135

VISTA I

Preparation	Review LB 130-142
HW due	None
HW assignment	None

CALENDAR AND HOMEWORK SUMMARY
UNIT IV



CONSTRUCTING FORECASTS USING FUTURE WHEELS

Preparation	Review LB 145-147 and Reference Section on future wheels
HW due	None
HW assignment	Personal future wheel and an autobiography

CONSTRUCTING FORECASTS USING SCENARIOS

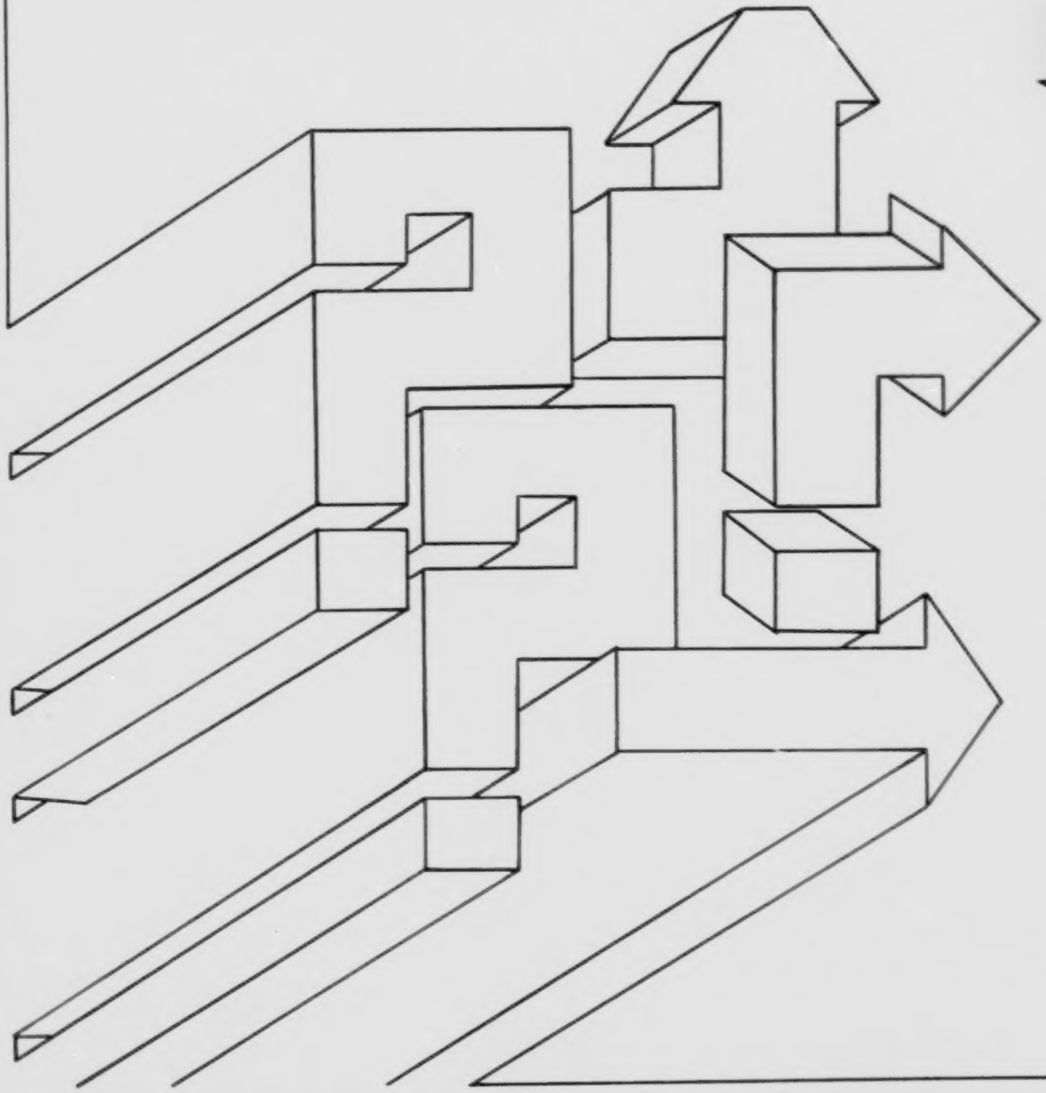
Preparation	Review LB 148-150 and Reference Section on scenarios
HW due	Personal future wheel and autobiography
HW assignment	Complete scenarios

VISTA II

Preparation	Review all directions and student materials Set a schedule for tasks to be accomplished
HW due	None
HW assignment	None

MAKING CHANGES

a futures-oriented course in inventive problem solving



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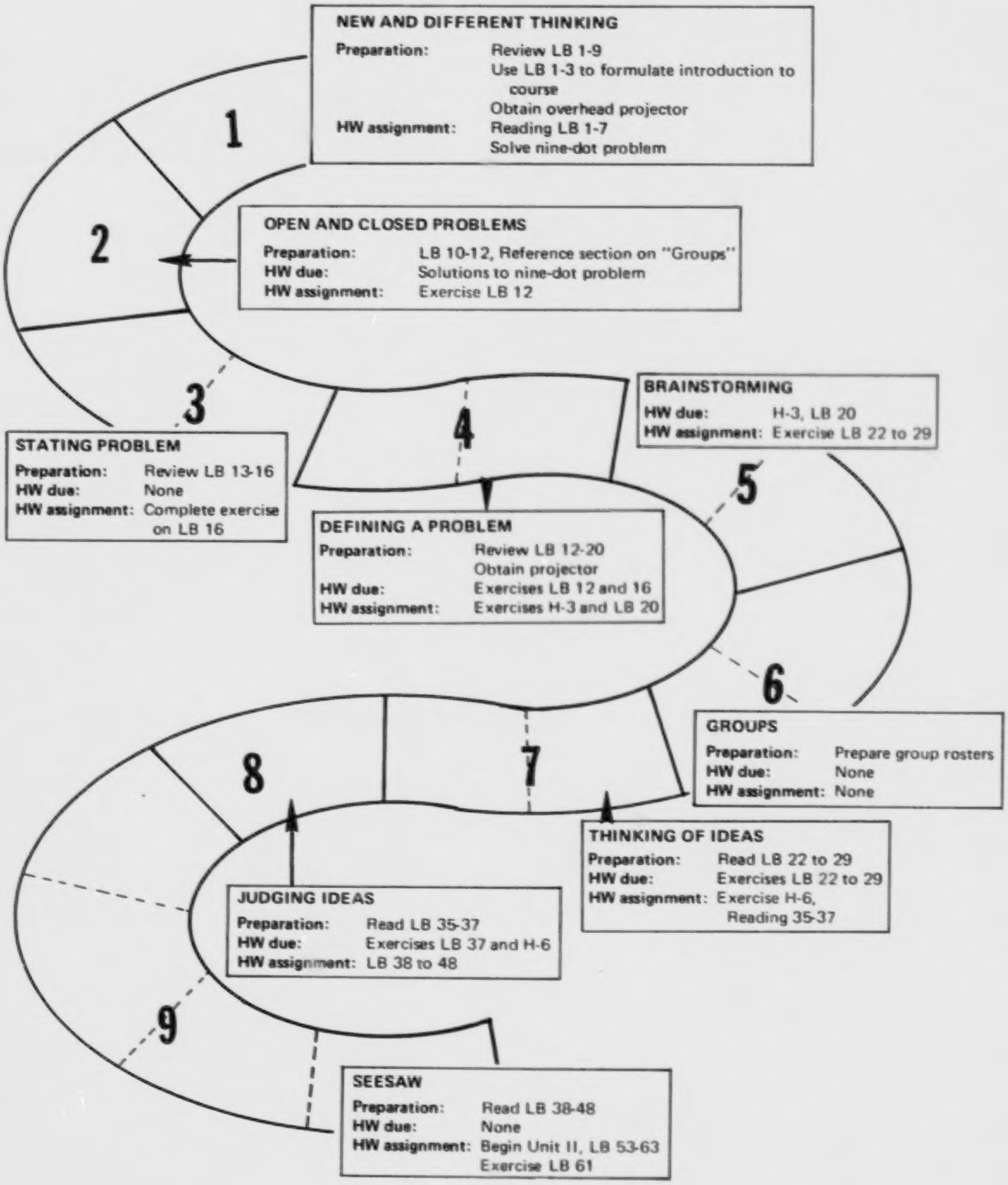
CALENDAR AND HOMEWORK SUMMARY

UNIT I



NEW AND DIFFERENT THINKING

Preparation:	Review LB 1-9 Use LB 1-3 to formulate introduction to course Obtain overhead projector
HW assignment:	Reading LB 1-7 Solve nine-dot problem

OPEN AND CLOSED PROBLEMS

Preparation:	LB 10-12, Reference section on "Groups"
HW due:	Solutions to nine-dot problem
HW assignment:	Exercise LB 12

STATING PROBLEM

Preparation:	Review LB 13-16
HW due:	None
HW assignment:	Complete exercise on LB 16

DEFINING A PROBLEM

Preparation:	Review LB 12-20 Obtain projector
HW due:	Exercises LB 12 and 16
HW assignment:	Exercises H-3 and LB 20

BRAINSTORMING

HW due:	H-3, LB 20
HW assignment:	Exercise LB 22 to 29

GROUPS

Preparation:	Prepare group rosters
HW due:	None
HW assignment:	None

THINKING OF IDEAS

Preparation:	Read LB 22 to 29
HW due:	Exercises LB 22 to 29
HW assignment:	Exercise H-6, Reading 35-37

JUDGING IDEAS

Preparation:	Read LB 35-37
HW due:	Exercises LB 37 and H-6
HW assignment:	LB 38 to 48

SEESAW

Preparation:	Read LB 38-48
HW due:	None
HW assignment:	Begin Unit II, LB 53-63 Exercise LB 61

NEW AND DIFFERENT THINKING

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Setting the stage. Describe the course.	LB-3	5-10
2. Physical habits. Students perform two everyday actions in reverse.		3-5
3. Mental habits — the Lost Ball Problem. Students generate and discuss solutions.	T-1	8-12
4. Mental habits — the Two Strings Problem. Students generate and discuss solutions.	T-2	8-15
optional break point		
5. New and different thinking. Students generate and discuss solutions to two problems.	LB-8 and 9	5-10
6. Solution ideas. Review and discuss solution ideas.	LB-6 and 7	10-15
7. Homework. Students read pages 1-7 in the Lesson Book and solve the nine-dot problem before the next lesson period.	LB-1 to 7	5

Unit I
Lesson 1

NEW AND DIFFERENT THINKING

GOALS:

To introduce the *Making Changes* course;
To engage students in activities in which habits may be resisted in favor of new and different approaches.

OBJECTIVES:

Students will be able to distinguish "habit thinking" from "new and different" thinking with respect to each of the examples given.

MATERIALS:

Lesson Books, notebooks, T-1 and T-2 (Lost Ball and Two Strings transparencies).

DIRECTIONS:

1. Setting the stage

   a. Give each student a Lesson Book.

   b. Provide students with enough information to create an awareness of the nature and purpose of the *Making Changes* course. Use pages 3 and 4 in the Lesson Book and what you have learned about the course from looking at the materials.

2. Physical habits

   a. Ask students who have shoes with laces to stand up, untie their laces, and then retie them. Have them repeat the actions using their left hands for actions usually performed by their right hands (vice versa for left-handed students).

   b. Ask all students to stand and fold their arms in front of them. Then have them fold their arms in the opposite way.

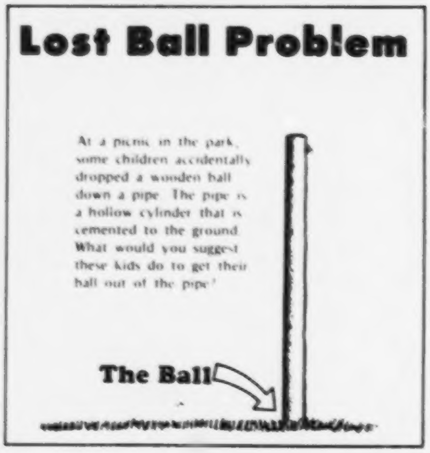
   c. Ask for reactions as to comfort or difficulty of each action.

> *People tend to adopt patterns of behavior early in life and it is difficult or uncomfortable to break out of those patterns.*

3. Mental habits — the Lost Ball Problem

   a. Project the transparency. Ask the students to work individually, noting possible solutions in their notebooks.

   Students may ask for additional information. You may need to tell them that the pipe is about 5 feet high, 3 inches in diameter, and that the ball is 2½ inches in diameter.



Lost Ball Problem

At a picnic in the park, some children accidentally dropped a wooden ball down a pipe. The pipe is a hollow cylinder that is cemented to the ground. What would you suggest these kids do to get their ball out of the pipe?

b. After 2-3 minutes, ask for a show of hands to see how many students have a solution.

You may either ask for ideas or ask that students keep their ideas to themselves. If you would like all students to discover the solution on their own, you may use the hints below.

Hint one:	Instead of trying to think of ways to reach the ball or ways to fish it out, how could you get the ball to come to you?
Hint two:	When washing dishes by hand, how do you clean the bottom of glasses that are too tall and narrow to reach with a sponge?
Hint three:	How do pump sprays work? How do you get liquid detergent out of a bottle equipped with a pump spray?

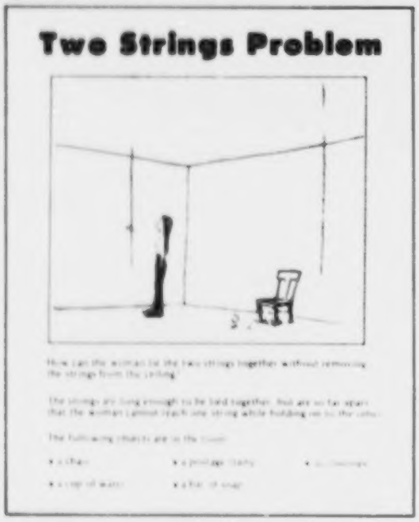
The problem is easily solved by pouring water into the pipe. Students may suggest the use of two sticks (difficult) or bubble gum (the ball may be too heavy) or a vacuum cleaner (not available in a park).

c. You may wish to discuss the following:

Habit thinking suggests: "How do I get the ball out?" New and different thinking suggests a reversal: "How do I get the ball to get out by itself?" Looking at things from different angles or reversing situations is helpful in new and different thinking.

4. Mental habits — The Two Strings Problem

   a. Show students the transparency. Ask students to work individually, noting possible solutions in their notebooks.



Two Strings Problem

   b. After a few minutes, ask for a volunteer to name the object(s) used in his or her solution. Determine how many students used the same object. If most students name the same object, allow a few minutes more for generation of alternative solutions.

   c. Review the following solution ideas. You may wish to record them on the board. As you do so, encourage students to express their ideas clearly, stating the method, materials, and the new and different way in which an object was used.

SOLUTION IDEAS

Operative Word	*Method*	*Materials and Use*
Extension	Lengthen one string so that it will reach the other.	Envelope — tear it into a continuous strip. Stamp — used to join string to envelope.
Anchor	Join one string to chair at center. Bring second string to center.	Chair — used as anchor. Stamp — used to join string to chair.
Skyhook	Hold one string. Stand on chair. Fix string to ceiling as near to second string as possible. Tie strings together.	Chair — used as ladder. Stamp — used to stick string to ceiling (wet soap also could be a sticking agent).

SOLUTION IDEAS

Operative Word	*Method*	*Materials and Use*
Pendulum	Weight one string and set it swinging toward center. Hold other string and catch the first on a forward swing.	Cup (empty) or soap — used as weight.

> *People tend to think that they must use all the materials, or they see each object serving its traditional function only. But when habitual thinking patterns are changed, new and different ideas become apparent.*

5. New and different thinking

   a. Have students read pages 8-9 in their Lesson Books (individually and silently). Point out the sketches of pencils in the margins. Explain that this symbol means that students are to write or draw in their notebooks.

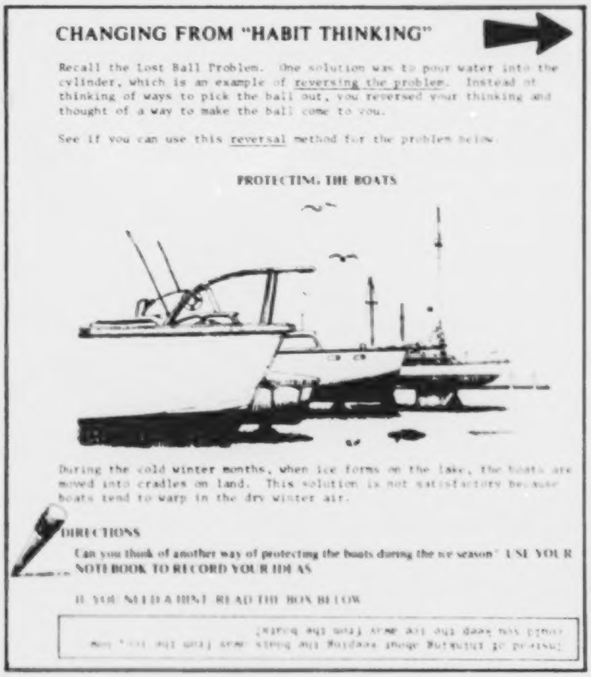
   b. Tell students to follow the directions given in the Lesson Book, going on to page 9 as soon as they are satisfied with their answers to the problem on page 8.

   If some students say they have finished before the others, point out that each problem can be solved in more than one way. Encourage them to think of more solution ideas.

6. Solution ideas

   For each of the problems, ask volunteers to state the total number of solution ideas, describe the ways in which the "hints" were helpful, and describe one idea that was new and different.

   Protecting the boats. *A variety of answers are possible. Using the reversal method, ice can be kept away from the boats through the use of some kind of cushioned shield or by using an air compressor or other device that would heat the water below the boats.*



CHANGING FROM "HABIT THINKING"

Recall the Lost Ball Problem. One solution was to pour water into the cylinder, which is an example of reversing the problem. Instead of thinking of ways to pick the ball out, you reversed your thinking and thought of a way to make the ball come to you.

See if you can use this reversal method for the problem below.

PROTECTING THE BOATS

During the cold winter months, when ice forms on the lake, the boats are moved into cradles on land. This solution is not satisfactory because boats tend to warp in the dry winter air.

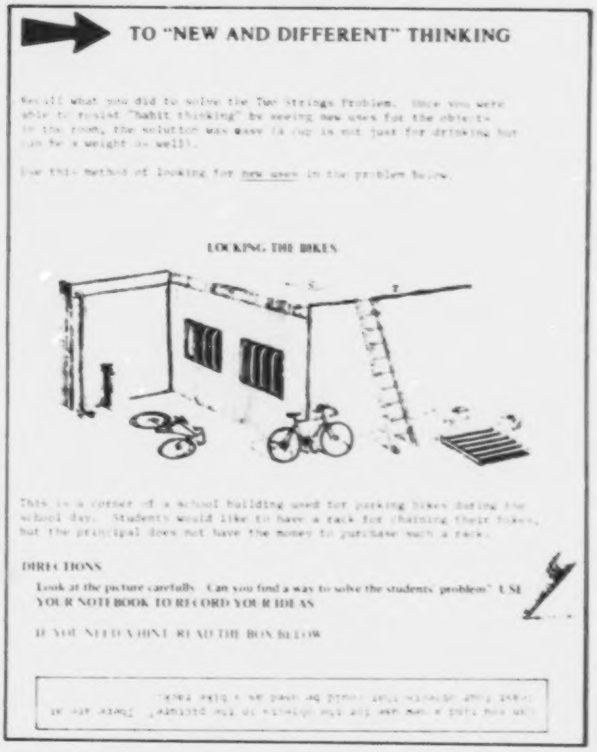
DIRECTIONS

Can you think of another way of protecting the boats during the ice season? USE YOUR NOTEBOOK TO RECORD YOUR IDEAS

IF YOU NEED A HINT READ THE BOX BELOW

Instead of thinking about keeping the boats away from the ice, how could you keep the ice away from the boats?

Locking the bikes. *The illustration shows a ladder which could be positioned horizonally to serve as a rack when the front wheels of the bikes are raised to the height of the window; and the pallets which could be used in several ways. It also might be possible to use the drainpipe in some fashion.*



TO "NEW AND DIFFERENT" THINKING

Recall what you did to solve the Two Strings Problem. Once you were able to resist "habit thinking" by seeing new uses for the objects in the room, the solution was easy (a cup is not just for drinking but can be a weight as well).

Use this method of looking for new uses in the problem below.

LOCKING THE BIKES

This is a corner of a school building used for parking bikes during the school day. Students would like to have a rack for chaining their bikes, but the principal does not have the money to purchase such a rack.

DIRECTIONS

Look at the picture carefully. Can you find a way to solve the students' problem? USE YOUR NOTEBOOK TO RECORD YOUR IDEAS.

IF YOU NEED A HINT, READ THE BOX BELOW.

Can you find a new use for the objects in the picture? There are at least four objects that could be used as a bike rack.

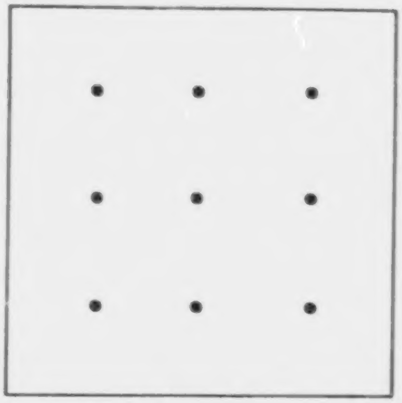
7. Homework

   a. Have students read pages 1-7 in the Lesson Book.

   b. Draw the pattern of nine dots on the board and ask students to copy the pattern in their notebooks.

   The problem is to connect all nine dots, using four straight lines, without taking the pencil off the paper and without retracing any line.

   Students should be prepared to show their attempts and the solution (if they find it) at the beginning of the next lesson period.



OPEN AND CLOSED PROBLEMS

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Nine-dot problem. Review homework responses.		5-10
2. Open-ended vs. close-ended problems. Students distinguish between two types of problems. Discuss.	LB-10	5-12
3. Complaints vs. challenges. Students convert complaints to challenges. Review and discuss.	LB-11	5-15
4. Optional — More complaints and challenges. Students state complaints and convert them to challenges.		5-15
5. Group choice. Explain grouping. Students fill out Group Choice Forms.	H-1	10-15
6. Homework. Students follow directions on page 12, completing the assignment before Lesson 4.	LB-12	3

OPEN AND CLOSED PROBLEMS

GOALS:

To teach the distinction between "open-ended" and "close-ended" problems;
To teach the distinction between complaints and challenges;
To give students practice at restating problems as challenges.

OBJECTIVES:

Students will be able to define "open-ended problem" and "challenge statement."
Students will be able to distinguish between close-ended and open-ended problems, and between complaints and challenges.

MATERIALS:

Lesson Books, notebooks, H-1 (Group Choice Form).

PREPARATION:

Read the reference section headed "Groups" in this manual. Students should have attempted to solve the nine-dot problem and read pages 1-7 in the Lesson Book.

DIRECTIONS:

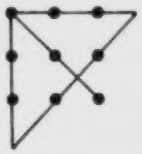
1. Nine-dot problem

The nine-dot problem can be used effectively as an illustration of resisting habit thinking by "going outside the lines." The problem also can be used as an example of a close-ended problem (one solution) as opposed to an open-ended problem (many possible solutions).

The following represents a suggested sequence of steps. You may wish to abbreviate this activity.

a. Determine how many students have solved the nine-dot problem.

b. If a significant number of students have attempted but failed to solve the problem, solicit hints from the other students.



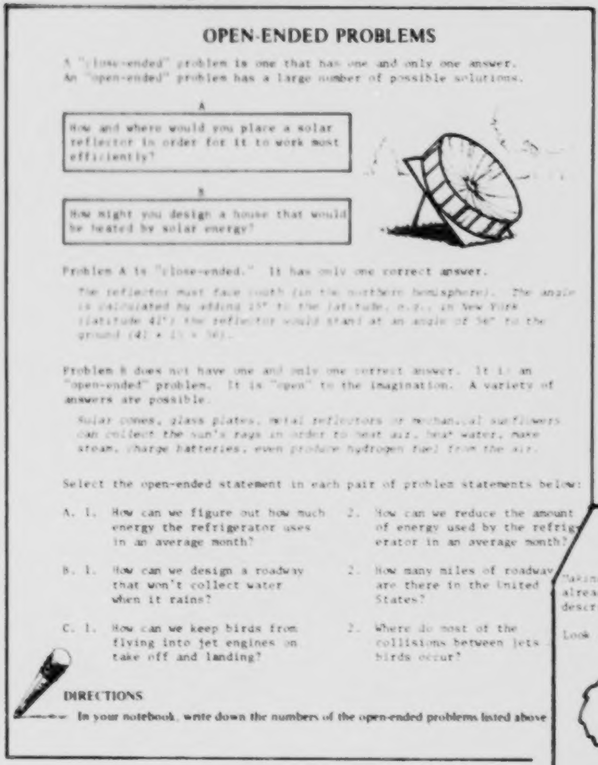
c. Ask for a volunteer to draw the solution on the board.

d. Ask this student or others to describe how he or she solved the problem, i.e., was it trial and error or did someone have an "Aha!" experience? Ask students if they can think of ways that this kind of solution could be used to solve other problems.

2. Open-ended vs. close-ended problems

   a. Point out that the nine-dot problem is different from the problems on pages 8 and 9 in that it has one and only one solution.

   b. Have students read page 10 in their Lesson Books and write responses in their notebooks.



OPEN-ENDED PROBLEMS

A "close-ended" problem is one that has one and only one answer. An "open-ended" problem has a large number of possible solutions.

A

How and where would you place a solar reflector in order for it to work most efficiently?

B

How might you design a house that would be heated by solar energy?

Problem A is "close-ended." It has only one correct answer.

The reflector must face south (in the northern hemisphere). The angle is calculated by adding 15° to the latitude, e.g., in New York (latitude 41°) the reflector would stand at an angle of 56° to the ground (41 + 15 = 56).

Problem B does not have one and only one correct answer. It is an "open-ended" problem. It is "open" to the imagination. A variety of answers are possible.

Solar cones, glass plates, metal reflectors or mechanical sunflowers can collect the sun's rays in order to heat air, heat water, make steam, charge batteries, even produce hydrogen fuel from the air.

Select the open-ended statement in each pair of problem statements below:

A. 1. How can we figure out how much energy the refrigerator uses in an average month?
2. How can we reduce the amount of energy used by the refrigerator in an average month?

B. 1. How can we design a roadway that won't collect water when it rains?
2. How many miles of roadway are there in the United States?

C. 1. How can we keep birds from flying into jet engines on take off and landing?
2. Where do most of the collisions between jets and birds occur?

DIRECTIONS

In your notebook, write down the numbers of the open-ended problems listed above

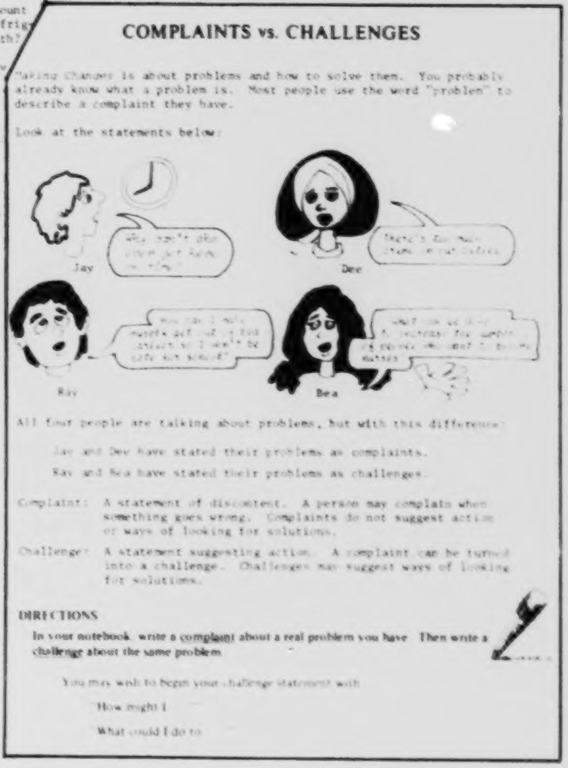
   c. Review students' responses. *A.2., B.1. and C.1. are open-ended problems.*

   Point out that not all "problems" are problems. When you have a question and you know how to find an answer or when you have a decision to make where you simply must make a choice, you don't really have a problem. Problems occur when you are blocked, when you don't know what to do. Open-ended problems are ones that can be solved by more than one method.

Complaints vs. challenges

   a. Have students read page 11 in their Lesson Books and write responses.

   b. Review the distinction between complaints and challenges as well as students' challenge statements.



COMPLAINTS vs. CHALLENGES

Making Changes is about problems and how to solve them. You probably already know what a problem is. Most people use the word "problem" to describe a complaint they have.

Look at the statements below:

All four people are talking about problems, but with this difference:

Jay and Dee have stated their problems as complaints.

Ray and Bea have stated their problems as challenges.

Complaint: A statement of discontent. A person may complain when something goes wrong. Complaints do not suggest action or ways of looking for solutions.

Challenge: A statement suggesting action. A complaint can be turned into a challenge. Challenges may suggest ways of looking for solutions.

DIRECTIONS

In your notebook, write a complaint about a real problem you have. Then write a challenge about the same problem.

You may wish to begin your challenge statement with

"How might I ___"

"What could I do to ___"

As the course progresses students will be asked to state a problem as a challenge, or to write challenge statements. It is important that they understand:

- *Problems can be stated in a variety of ways.*
- *Problems stated as complaints may imply a "do nothing, don't care" attitude.*
- *Problems stated as challenges imply action.*
- *Problems are more likely to be solved successfully if people understand and agree on a specific challenge statement.*

4. Optional — more complaints and challenges

   a. Choose a topic familiar to the students such as cafeteria lunches, school policies, or teenage poverty.

   b. Ask students to state as many complaints as they can in three minutes.

   c. Ask the students to choose up to three of these major complaints and state them as challenges. Encourage broad challenge statements.

5. Group choice

   a. Explain that later on students will be working in small groups. From your reading of the reference section headed "Groups" and other course materials, acquaint students with the kinds of roles and tasks that will be used.

   b. Have students complete H-1 (Group Choice Form). Encourage them to choose students who are likely to have good ideas and who will be productive in group work.

   c. Collect the Group Choice Forms.

   You will need to have the group rosters ready for Lesson 6. See the reference section on "Groups" in order to make up these rosters.

6. Homework

   Refer students to page 12 in the Lesson Book. Tell them they will be expected to hand in their responses to this assignment during Lesson 4.

STATING A PROBLEM

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Introduction. Define and clarify terminology.		3-5
2. Using HOW?, VERB CHANGE and REVERSAL. Students read and respond to Lesson Book pages. Review the method and students' responses for each of the three methods.		
a. HOW?	LB-13	10-20
b. VERB CHANGE	LB-14	10-20
c. REVERSAL	LB-15	10-20
optional break point		
3. Using all three methods. Students write problem statements.	LB-16	10-25
4. Homework. Assign uncompleted tasks from page 16 as well as page 12. (the bus design problem).	LB-12 and 16	3

STATING A PROBLEM

GOALS:

To introduce and compare three methods of stating a problem;
To provide for practice in applying all three methods to problems.

OBJECTIVES:

Given a complaint, students will be able to restate the problem as a challenge using the HOW? technique.
Given a complaint and a restatement using HOW?, students will be able to restate the problem using the VERB CHANGE technique.
Given a complaint and a restatement using HOW?, students will be able to restate the problem using the REVERSAL technique.
Given a complaint, students will be able to restate the problem using all three methods.

MATERIALS:

Lesson Books and notebooks.

DIRECTIONS:

1. Introduction

Write the following phrases on the board:

problem statement/stating a problem
restating a problem/problem restatement

Briefly go over the meaning of each phrase.

Problem statement is a one-sentence description of a problem written as a challenge. The act of writing this statement will be referred to as "stating a problem." If students are asked to come up with alternative statements, they will be "restating" a problem.

A "restatement" can be describing the problem as a challenge or stating it as a different kind of challenge.

2. Using HOW?, VERB CHANGE and REVERSAL

Pages 13, 14 and 15 in the Lesson Book present three methods of stating a problem. For each method, two practice problems are given. For each method, the following strategy is recommended:

a. Have students read the relevant Lesson Book page.

b. Have students suggest restatements for practice problem #1.

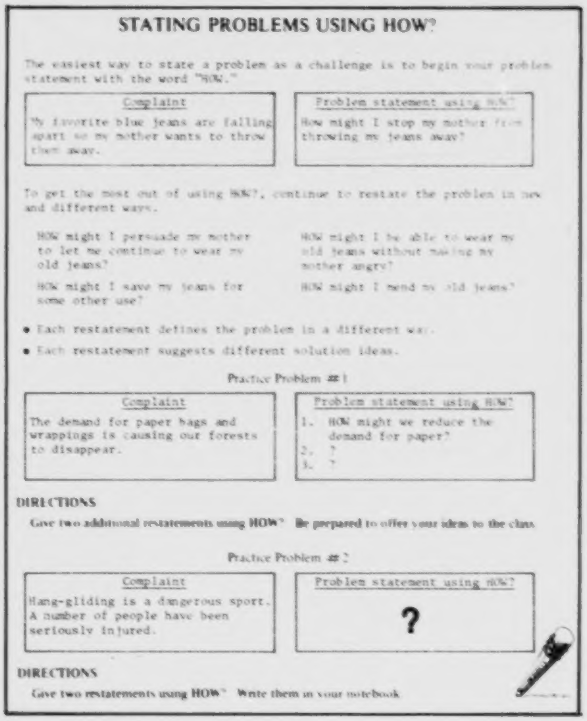
c. Review restatements and clarify the method as necessary.

d. Have students write restatements for practice problem #2.

e. Review responses to practice problem #2 in one of the following ways: Walk around while students are writing and provide guidance and reinforcement as needed; call on volunteers to read their restatements to the class; or collect responses and provide written comments.

> *To increase student motivation, you may wish to ask students to suggest solution ideas arising from problem restatements in order to illustrate that each restatement may suggest a different way that the problem might be attacked.*

Stating Problems Using HOW?



STATING PROBLEMS USING HOW?

The easiest way to state a problem as a challenge is to begin your problem statement with the word "HOW."

Complaint	Problem statement using HOW?
My favorite blue jeans are falling apart so my mother wants to throw them away.	How might I stop my mother from throwing my jeans away?

To get the most out of using HOW?, continue to restate the problem in new and different ways.

HOW might I persuade my mother to let me continue to wear my old jeans?

HOW might I be able to wear my old jeans without making my mother angry?

HOW might I save my jeans for some other use?

HOW might I mend my old jeans?

- Each restatement defines the problem in a different way.
- Each restatement suggests different solution ideas.

Practice Problem #1

Complaint	Problem statement using HOW?
The demand for paper bags and wrappings is causing our forests to disappear.	1. HOW might we reduce the demand for paper? 2. ? 3. ?

DIRECTIONS

Give two additional restatements using HOW? Be prepared to offer your ideas to the class.

Practice Problem #2

Complaint	Problem statement using HOW?
Hang-gliding is a dangerous sport. A number of people have been seriously injured.	?

DIRECTIONS

Give two restatements using HOW? Write them in your notebook.

Example of Responses

Practice Problem #1

How might we persuade people to do without paper bags?
How might we make paper without cutting down trees?
How might we recycle paper bags?
How might we make more forests?
How might we get more paper out of our forests?

Practice Problem #2

How might we reduce injuries?
How might we make safer gliders?
How might we train people/supervise people better?
How might we make landings softer?

Stating Problems Using VERB CHANGE

You may wish to encourage students to use a dictionary or thesaurus.

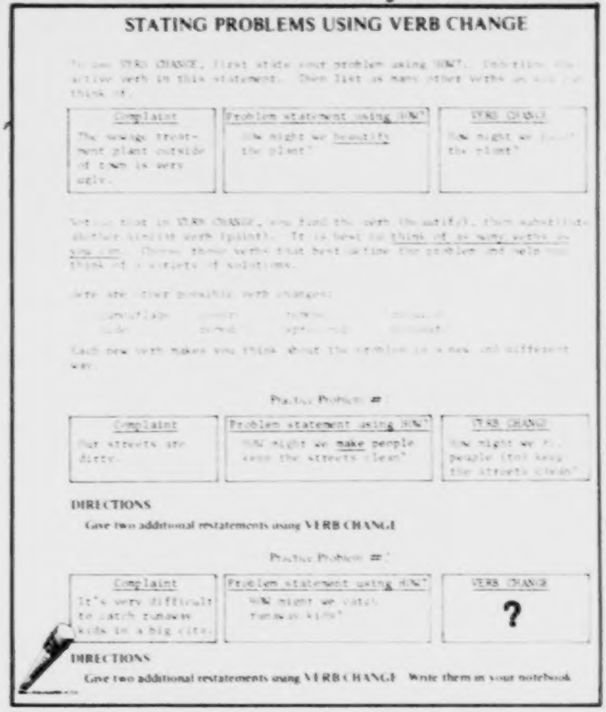
Examples of Responses

Practice Problem #1

Persuade, encourage, teach, train, pay, hire, force threaten, brainwash.

Practice Problem #2

Find, trap, hunt, track, help, attract, educate, get rid of, eliminate.



STATING PROBLEMS USING VERB CHANGE

To use VERB CHANGE, first state your problem using HOW?. Underline the active verb in this statement. Then list as many other verbs as you can think of.

Complaint	Problem statement using HOW?	VERB CHANGE
The sewage treatment plant outside of town is very ugly.	How might we beautify the plant?	How might we [illegible] the plant?

Notice that in VERB CHANGE, you find the verb (beautify), then substitute another similar verb (paint). It is best to think of as many verbs as you can. Choose those verbs that best define the problem and help you think of a variety of solutions.

Here are other possible verb changes:

camouflage [illegible] [illegible] [illegible]
hide [illegible] [illegible] [illegible]

Each new verb makes you think about the problem in a new and different way.

Practice Problem #1

Complaint	Problem statement using HOW?	VERB CHANGE
Our streets are dirty.	HOW might we make people keep the streets clean?	How might we [illegible] people (to) keep the streets clean?

DIRECTIONS

Give two additional restatements using VERB CHANGE

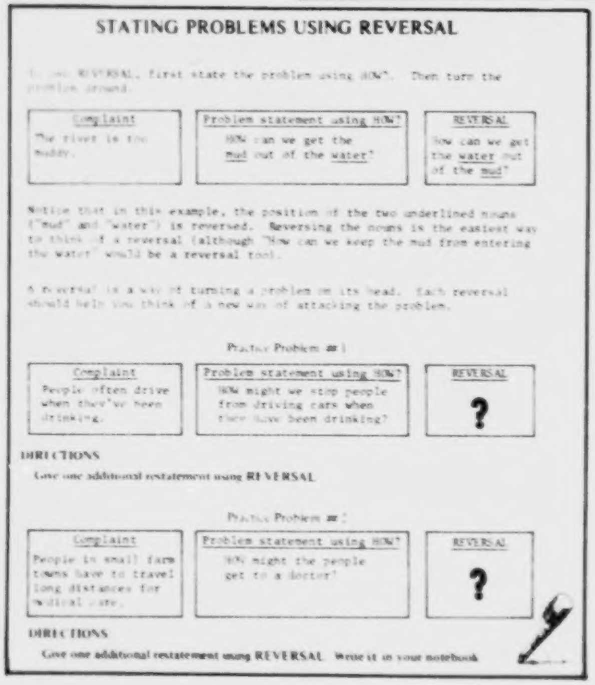
Practice Problem #2

Complaint	Problem statement using HOW?	VERB CHANGE
It's very difficult to catch runaway kids in a big city.	HOW might we catch runaway kids?	?

DIRECTIONS

Give two additional restatements using VERB CHANGE. Write them in your notebook.

Stating Problems Using REVERSAL



STATING PROBLEMS USING REVERSAL

To use REVERSAL, first state the problem using HOW?. Then turn the problem around.

Complaint	Problem statement using HOW?	REVERSAL
The river is too muddy.	HOW can we get the mud out of the water?	How can we get the water out of the mud?

Notice that in this example, the position of the two underlined nouns ("mud" and "water") is reversed. Reversing the nouns is the easiest way to think of a reversal (although "How can we keep the mud from entering the water" would be a reversal too).

A reversal is a way of turning a problem on its head. Each reversal should help you think of a new way of attacking the problem.

Practice Problem #1

Complaint	Problem statement using HOW?	REVERSAL
People often drive when they've been drinking.	HOW might we stop people from driving cars when they have been drinking?	?

DIRECTIONS

Give one additional restatement using REVERSAL

Practice Problem #2

Complaint	Problem statement using HOW?	REVERSAL
People in small farm towns have to travel long distances for medical care.	HOW might the people get to a doctor?	?

DIRECTIONS

Give one additional restatement using REVERSAL. Write it in your notebook.

Examples of Responses

Practice Problem #1

How might we stop cars from moving when drivers have been drinking?
How might we remove the cars or the drinking completely?

Practice Problem #2

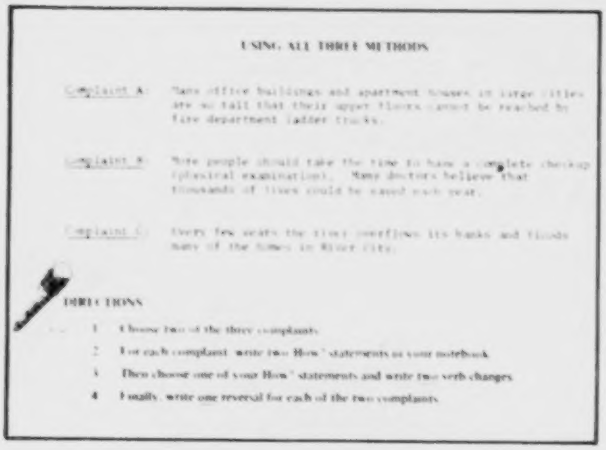
How might the people get a doctor to come to them?
How might a doctor (or medical care facilities) be available at all times and places?

3. Using all three methods

Have students read page 16 and follow the directions.

This assignment can be used to check students' acquired skills. You might ask students to hand in their notebooks at the end of the period or, if they need additional time, to complete the assignment as homework.

Give additional large- or small-group practice as needed. Possible student answers for the problems on page 16 include:



USING ALL THREE METHODS

Complaint A: Many office buildings and apartment houses in large cities are so tall that their upper floors cannot be reached by fire department ladder trucks.

Complaint B: More people should take the time to have a complete checkup (physical examination). Many doctors believe that thousands of lives could be saved each year.

Complaint C: Every few years the river overflows its banks and floods many of the homes in River City.

DIRECTIONS

1. Choose two of the three complaints.
2. For each complaint, write two "How" statements in your notebook.
3. Then choose one of your "How" statements and write two verb changes.
4. Finally, write one reversal for each of the two complaints.

Complaint A

HOW?	*How can we reach the upper floors?*
HOW?	*How can we bring people down?*
HOW?	*How can we extend the ladders?*
VERB CHANGE	*How can people fly/slide/climb down?*
VERB CHANGE	*How can we climb to upper floors?*
REVERSAL	*How can we raise the people up and out?*
REVERSAL	*How can we take the firefighters up?*
REVERSAL	*How can we make the buildings fireproof?*

Complaint B

HOW?	*How can we convince people to have a checkup?*
HOW?	*How can we make checkups more attractive?*
HOW?	*How can we make people want to get a checkup?*
VERB CHANGE	*How can we pay people to get a checkup?*
VERB CHANGE	*How can we persuade /force people to get a checkup?*
REVERSAL	*How can we take checkups to the people?*
REVERSAL	*How can we eliminate the need for checkups?*

Complaint C

HOW?	*How can we protect the homes?*
HOW?	*How can we strengthen the riverbanks?*
HOW?	*How can we stop floods?*
VERB CHANGE	*How can we raise/change/move the riverbanks?*
VERB CHANGE	*How can we raise/change/waterproof the homes?*
REVERSAL	*How can we divert the river?*
REVERSAL	*How can we lower the river?*
REVERSAL	*How can we keep the extra water out of the river in the first place?*

4. Homework

   a. If students have not completed the task described on page 16 of the Lesson Book, you may ask them to do so for homework and to hand in their responses to you before the next lesson.

   b. Remind students that they should have the tasks assigned on page 12 completed for the next lesson as well.

DEFINING A PROBLEM

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Overview. Explain lesson objectives.	LB-12 H-2	3
2. The mess. Explain or discuss the concept of the problem as given. Refer to the bus problem. Students use handout.	T-3 H-2 LB-12	5-8
3. Challenge statements. Explain the concept of the problem as understood. Refer to the Bus Design problem. Students use handout.	T-3 H-2 LB-12	5-10
4. Explosion. Explain the use of the explosion method for breaking down a problem into its parts.	T-3 H-2 LB-12	10-20
optional break point		
5. Broad terms. Explain the concept. Assign exercises. Review responses.	T-3 and H-2 LB-18 and 19	10-20
6. Defining the Bus Design problem in broad terms. Students generate broad terms definitions using their explosion diagrams.	LB-12	8-20
7. Homework. Students practice generating broad terms definitions.	LB-20 H-3	3-5

DEFINING A PROBLEM

GOALS:

To present an overview of the definition phase of problem solving;
To reinforce the use of CHALLENGE STATEMENTS;
To introduce the technique of EXPLOSION;
To introduce and provide practice in stating a problem in BROAD TERMS.

OBJECTIVES:

Students will be able to define and explain the function of: the mess, challenge statements, explosion, broad terms.
Given a "messy" problem statement, students will be able to identify major problematic factors by using the EXPLOSION technique.
Given a problem statement and several restatements, students will be able to identify the broadest of the restatements.
Given a problem statement, students will be able to restate it as a challenge using BROAD TERMS.

MATERIALS:

Lesson Books, notebooks, T-3, H-2 (Defining Complex Problems), and H-3 (Broad Terms).

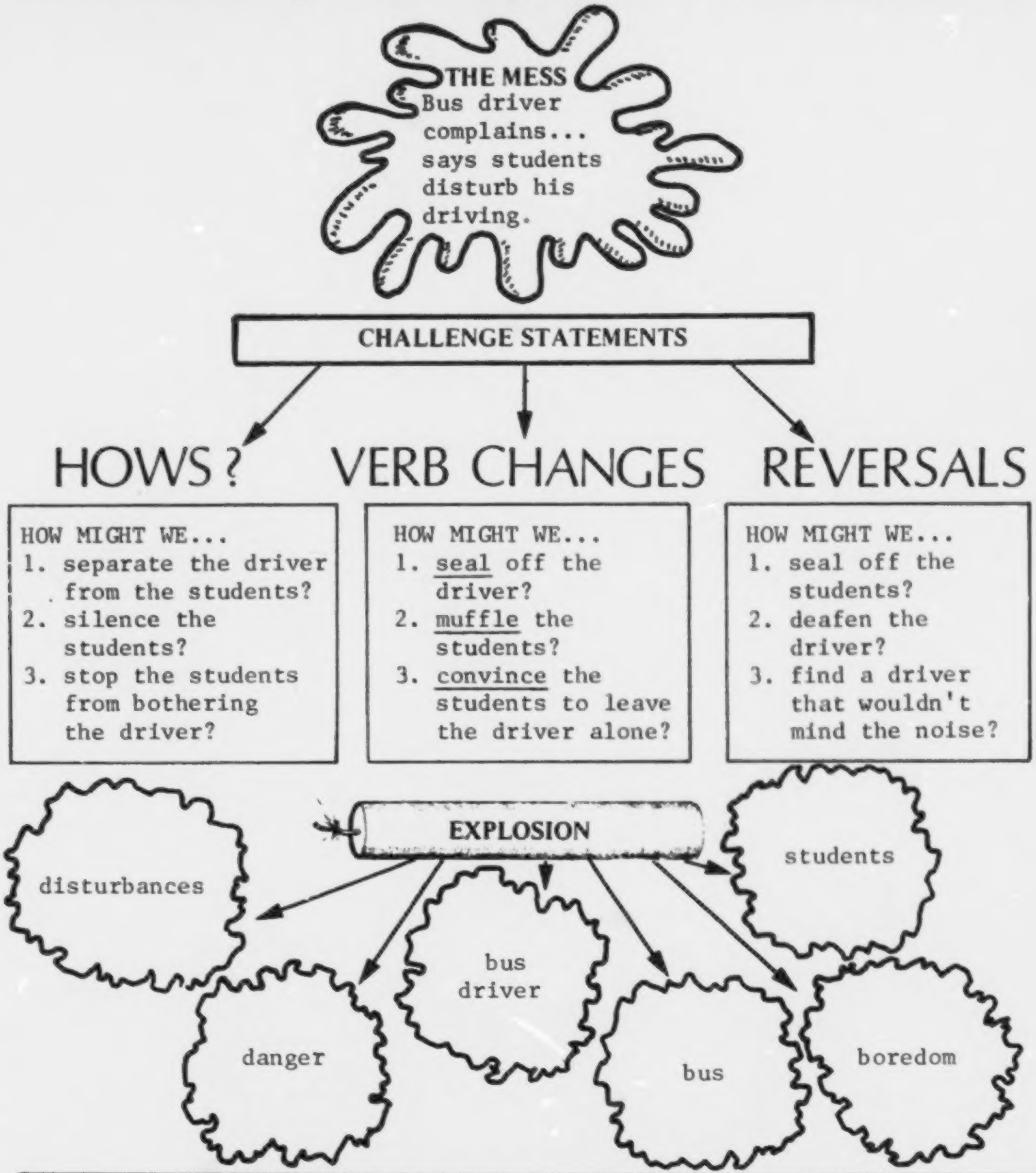
PREPARATION:

Read this lesson description and related student materials carefully prior to class time.
Students should have completed the tasks assigned on pages 12 and 16 of the Lesson Book.

INTRODUCTION:

Transparency T-3 and student handout H-2 are identical diagrammatic descriptions of the process of defining complex problems.
The diagram is repeated on page 17 of the Lesson Book, with each stage defined.
The diagram on page 21 of this manual illustrates the stages by giving sample responses to the Bus Design problem described on page 12 of the Lesson Book.

Defining Complex Problems



THE MESS
Bus driver complains... says students disturb his driving.

CHALLENGE STATEMENTS

HOWS?

HOW MIGHT WE...
1. separate the driver from the students?
2. silence the students?
3. stop the students from bothering the driver?

VERB CHANGES

HOW MIGHT WE...
1. seal off the driver?
2. muffle the students?
3. convince the students to leave the driver alone?

REVERSALS

HOW MIGHT WE...
1. seal off the students?
2. deafen the driver?
3. find a driver that wouldn't mind the noise?

EXPLOSION

STATING THE REAL PROBLEM USING BROAD TERMS

How might everybody on the bus be safe and happy?

How might we get students back and forth to school safely?

DIRECTIONS:

1. Overview

   a. Tell the students that the Bus Design problem given on page 12 of the Lesson Book serves as the focus for much of this lesson. Students should have page 12 in the Lesson Book and their responses and designs in front of them.

   b. Make sure that each student has a copy of H-2 (Defining Complex Problems). Explain that the headings given on the handout may be used as guides for the definition of any problem.

2. The mess

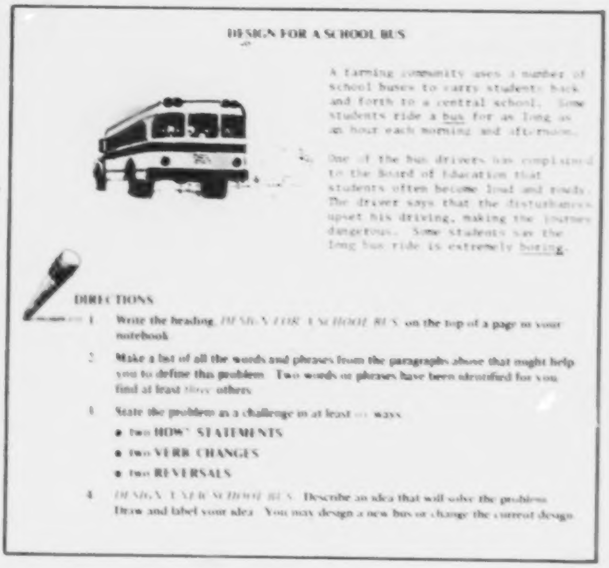
   a. Project the transparency.

   b. Explain that "the mess" is the problem as given. Explain or discuss this concept.

   Note that the mess, or problem as given, may be
   - *a simple complaint*
   - *several related complaints*
   - *a mixture of issues, conflicts, or sub-problems.*

   c. Ask students to identify the "mess" for the Bus Design problem.

   Response: the total problem description.



DESIGN FOR A SCHOOL BUS

A farming community uses a number of school buses to carry students back and forth to a central school. Some students ride a bus for as long as an hour each morning and afternoon.

One of the bus drivers has complained to the Board of Education that students often become loud and rowdy. The driver says that the disturbances upset his driving, making the journey dangerous. Some students say the long bus ride is extremely boring.

DIRECTIONS

1. Write the heading *DESIGN FOR A SCHOOL BUS* on the top of a page in your notebook.
2. Make a list of all the words and phrases from the paragraphs above that might help you to define this problem. Two words or phrases have been identified for you; find at least three others.
3. State the problem as a challenge in at least [illegible] ways:
   - two HOW? STATEMENTS
   - two VERB CHANGES
   - two REVERSALS
4. *DESIGN A NEW SCHOOL BUS.* Describe an idea that will solve the problem. Draw and label your idea. You may design a new bus or change the current design.

3. Challenge statements

   a. Have students write at least one challenge statement for each of the three methods for the Bus Design problem. If you wish, you may compare these statements with those suggested on page 21 of this manual. Remind students that each challenge statement can suggest a different approach to the problem. Point out that the challenge statements demonstrate the students' understanding of the problem (the problem as understood).

4. Explosion

"Exploding" a problem means analyzing a problem into its parts — those aspects of the situation that help make the problem a problem. There are two ways of exploding a problem:

- *Using imagery. Students close their eyes and try to imagine the problem as given being exploded into its separate parts.*

For many problems, the "parts" are not concrete and cannot be imaged (e.g., noise, boredom). Consequently, a second technique is recommended.

- *Using key words. Students read the problem and underline key words or phrases that help make the problem a problem.*

Completing an explosion can be a very useful step in problem solving. By naming all the parts of a problem, you can construct a problem definition that is broad enough to include all possible avenues of attack. In addition, the explosion diagram can serve as a reference for suggesting new ways of looking for a solution.

a. Write the word "Explosion" on the board.

b. Have students close their eyes and imagine that the bus is exploding in slow motion. Point out that the explosion separates all the parts of the problem without destroying any part.

c. Have students call out the parts they see. List those parts on the board.

d. Have students refer to their responses to question 2 from the homework assignment given on page 12. Supplement the list on the board with the key words and phrases from the mess statement offered by the students.

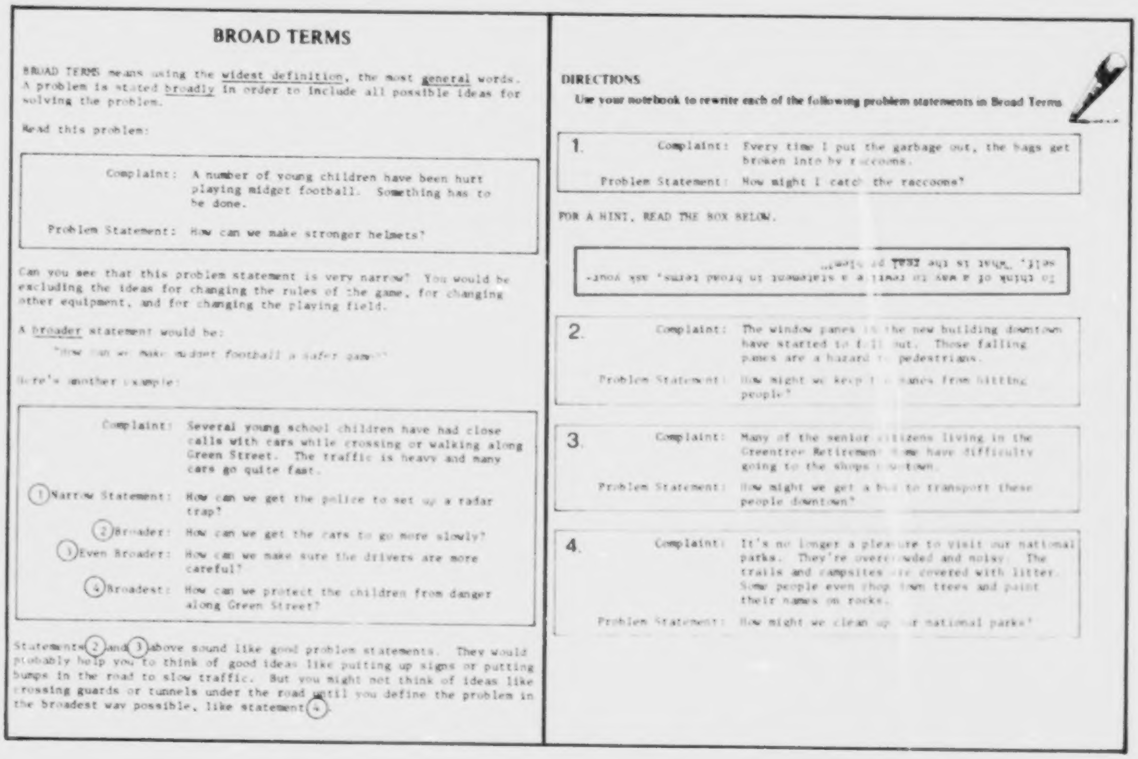
e. Have students evaluate the objects and factors listed to determine whether or not they are in fact contributors to the problem. You may help them by taking each object or factor in turn and asking, "Does this make the problem worse? If it didn't exist, would the problem be less serious?" Erase any object or factor considered irrelevant by the majority of students. Check the list with the chart on page 21 of this manual.

f. Have students fill in the exploded parts on the handout.

5. Broad terms

Some students may find this concept difficult and may have trouble generating appropriate broad terms challenge statements. It may be necessary to supplement the program by giving students practice in distinguishing general from specific statements.

a. Refer students to page 18 of the Lesson Book. Read along with them. Define and explain as necessary.



BROAD TERMS

BROAD TERMS means using the widest definition, the most general words. A problem is stated broadly in order to include all possible ideas for solving the problem.

Read this problem:

Complaint: A number of young children have been hurt playing midget football. Something has to be done.

Problem Statement: How can we make stronger helmets?

Can you see that this problem statement is very narrow? You would be excluding the ideas for changing the rules of the game, for changing other equipment, and for changing the playing field.

A broader statement would be:

"How can we make midget football a safer game?"

Here's another example:

Complaint: Several young school children have had close calls with cars while crossing or walking along Green Street. The traffic is heavy and many cars go quite fast.

① Narrow Statement: How can we get the police to set up a radar trap?

② Broader: How can we get the cars to go more slowly?

③ Even Broader: How can we make sure the drivers are more careful?

④ Broadest: How can we protect the children from danger along Green Street?

Statements ② and ③ above sound like good problem statements. They would probably help you to think of good ideas like putting up signs or putting bumps in the road to slow traffic. But you might not think of ideas like crossing guards or tunnels under the road until you define the problem in the broadest way possible, like statement ④.

DIRECTIONS

Use your notebook to rewrite each of the following problem statements in Broad Terms

1. Complaint: Every time I put the garbage out, the bags get broken into by raccoons.

Problem Statement: How might I catch the raccoons?

FOR A HINT, READ THE BOX BELOW.

To think of a way to rewrite a statement in broad terms, ask yourself, "What is the real problem?"

2. Complaint: The window panes in the new building downtown have started to fall out. Those falling panes are a hazard to pedestrians.

Problem Statement: How might we keep the panes from hitting people?

3. Complaint: Many of the senior citizens living in the Greentree Retirement Home have difficulty going to the shops downtown.

Problem Statement: How might we get a bus to transport these people downtown?

4. Complaint: It's no longer a pleasure to visit our national parks. They're overcrowded and noisy. The trails and campsites are covered with litter. Some people even chop down trees and paint their names on rocks.

Problem Statement: How might we clean up our national parks?

b. Have students complete the four items on page 19 of the Lesson Book. Encourage them in each instance to ask what the real problem is.

Possible responses:

1) *How might I get rid of my garbage safely?*
   How might I stop the raccoons from disturbing the garbage?

2) *How might the panes be kept from falling out?*

3) *How might the senior citizens get downtown?*
   How could senior citizens get their shopping needs taken care of?

4. *How might we invent a way to make visits to a national park more pleasant?*
How might we make campers more responsible?

Note that item 4 on page 19 of the Lesson Book is similar to the bus problem in that there are a number of parts to it. For this kind of complaint, it usually helps to underline the key words. Some mess statements contain more than one problem and cannot be defined in a single broad terms statement.

6. Defining the Bus Design problem in broad terms

a. Ask for volunteers to give broad terms challenge statements for the Bus Design problem.

b. Evaluate each suggestion by checking it against the explosion diagram and by asking if the definition describes the real problem. Ask students to consider whether there is a single problem or more than one problem in the complaint.

c. Collect students' designs for improving the bus. Display them around the room if you wish.

7. Homework

a. Assign H-3 and page 20 in the Lesson Book for the next session.

b. Have students look at the direction at the bottom of page 20. Point out that this direction means that students should write challenge statements, complete an explosion and write at least one broad terms definition.

BRAINSTORMING

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Review homework. Review students' responses to H-3 and page 20.	H-3 LB-20	5-15
2. Rule one: no criticism allowed. Explain brainstorming and rule one. Students brainstorm ideas for the "junked tires" problem.		5-15
3. Rule two: think of wild and unusual ideas. Explain rule two. Students brainstorm ideas for the Oil Tank Problem.	LB-21	5-15
4. Rule three: think of many, many ideas. Explain rule three. Students brainstorm ideas for the Temporary Classrooms Problem.	LB-21	5-15
5. Rule four: hitchhike on others' ideas. Explain rule four. Students continue with the Temporary Classrooms Problem.	LB-21	5-15
6. Blocks and aids. Lead students in determining ways in which brainstorming may be hindered or facilitated.		5-10
7. Homework. Students read pages 22-29 in their Lesson Books.	LB-22 to 29	3

BRAINSTORMING

GOALS:

To review the problem definition techniques of explosion and broad terms;
To introduce the rules of brainstorming;
To give students practice in using these rules separately and in concert;
To introduce the concepts of "blocks" and "aids" in thinking of ideas.

OBJECTIVES:

Students will be able to name and explain the four rules of brainstorming.
Students will be able to explain the function and utility of brainstorming.
Students will be able to name at least three possible blocks to and three possible aids for brainstorming.
Students will be able to brainstorm either alone or in a group.

PREPARATION:

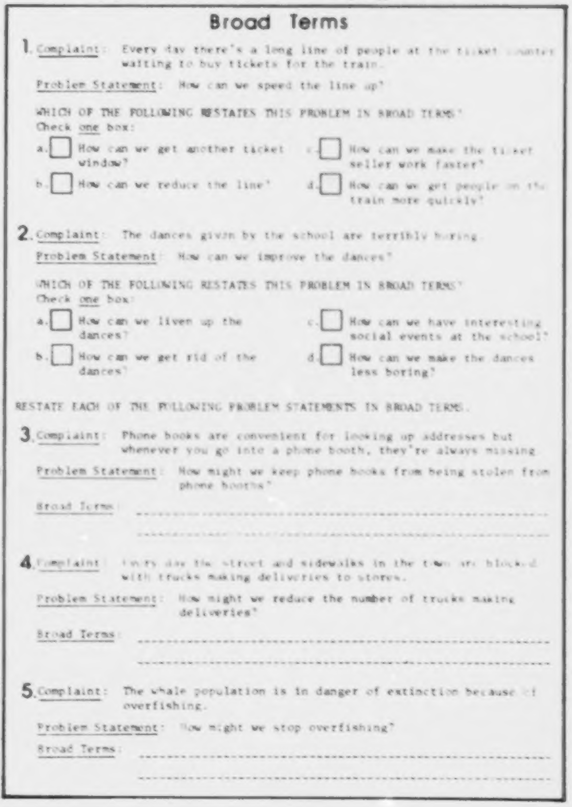
Read the reference section headed "Idea Generation" in this manual.
Students should have completed the tasks assigned on H-3 and page 20.

MATERIALS:

Lesson Books and notebooks.

DIRECTIONS:

1. Review the homework assignment
   a. The following are possible broad terms definitions for the assignment on H-3.
      1) *d*
      2) *c*
      3) *How might people be able to get information on addresses quickly and easily? How might we design a phone booth with a theft-proof phonebook?*
      4) *How might deliveries be made without interfering with traffic?*
      5) *How might we preserve the whale population?*



Broad Terms

1. Complaint: Every day there's a long line of people at the ticket counter waiting to buy tickets for the train.

Problem Statement: How can we speed the line up?

WHICH OF THE FOLLOWING RESTATES THIS PROBLEM IN BROAD TERMS?
Check one box:
a. ☐ How can we get another ticket window?
b. ☐ How can we reduce the line?
c. ☐ How can we make the ticket seller work faster?
d. ☐ How can we get people on the train more quickly?

2. Complaint: The dances given by the school are terribly boring.

Problem Statement: How can we improve the dances?

WHICH OF THE FOLLOWING RESTATES THIS PROBLEM IN BROAD TERMS?
Check one box:
a. ☐ How can we liven up the dances?
b. ☐ How can we get rid of the dances?
c. ☐ How can we have interesting social events at the school?
d. ☐ How can we make the dances less boring?

RESTATE EACH OF THE FOLLOWING PROBLEM STATEMENTS IN BROAD TERMS.

3. Complaint: Phone books are convenient for looking up addresses but whenever you go into a phone booth, they're always missing

Problem Statement: How might we keep phone books from being stolen from phone booths?

Broad Terms:

4. Complaint: Every day the street and sidewalks in the town are blocked with trucks making deliveries to stores.

Problem Statement: How might we reduce the number of trucks making deliveries?

Broad Terms:

5. Complaint: The whale population is in danger of extinction because of overfishing.

Problem Statement: How might we stop overfishing?

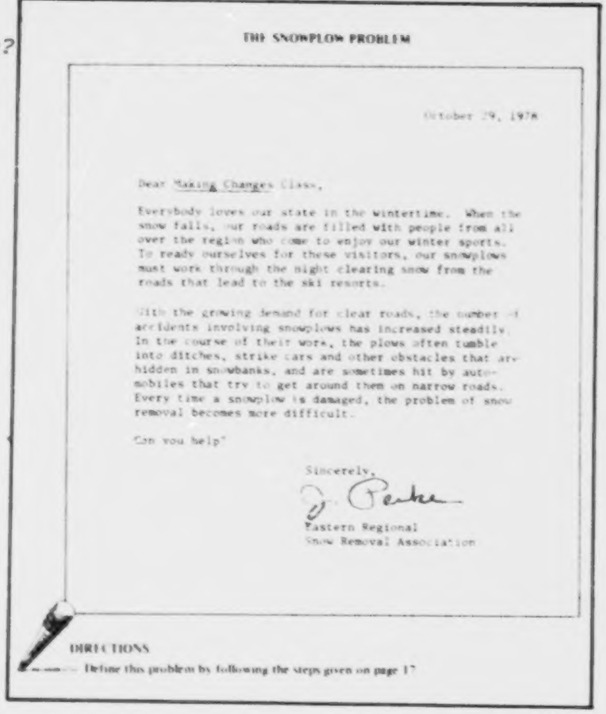
Broad Terms:

b. Challenge statements for the problem on page 20 might include:

- *How might we plow the roads without accidents?*
- *How might we clear the roads/make them passable/make them safe?*
- *How might we prevent the snow from causing problems?*

Explosion of the problem might yield:

- *cars*
- *roadways (narrow)*
- *plows*
- *snow*
- *accidents*
- *shoulders*
- *snowbanks*
- *obstacles*
- *winter sports*
- *ditches*



THE SNOWPLOW PROBLEM

October 29, 1978

Dear Making Changes Class,

Everybody loves our state in the wintertime. When the snow falls, our roads are filled with people from all over the region who come to enjoy our winter sports. To ready ourselves for these visitors, our snowplows must work through the night clearing snow from the roads that lead to the ski resorts.

With the growing demand for clear roads, the number of accidents involving snowplows has increased steadily. In the course of their work, the plows often tumble into ditches, strike cars and other obstacles that are hidden in snowbanks, and are sometimes hit by automobiles that try to get around them on narrow roads. Every time a snowplow is damaged, the problem of snow removal becomes more difficult.

Can you help?

Sincerely,
J. Parke
Eastern Regional
Snow Removal Association

DIRECTIONS
Define this problem by following the steps given on page 17

A broad terms definition for the Snowplow Problem might be:

- *How might people reach winter sports activities more safely?*
- *How might snow removal be accomplished without accidents?*

2. Brainstorming rule one: no criticism allowed

Many wild and wonderful ideas can only be generated in a non-critical environment. A good brainstorming session is fast-paced, informal and fun. Ideas and notes of ideas are nearly always single words or short phrases. There is often an atmosphere of urgency since brainstorming is like a scavenger hunt: the more ideas the better, and everything can be sorted out afterwards.

The "afterwards," when contributors run out of ideas, is the time for elaboration and evaluation. An elaborated idea may set off a mini-brainstorm, or evaluation of a wild idea may suggest a practical modification.

a. Write the following on the board:

Brainstorming Rules:
1) No criticism allowed

b. Tell students that brainstorming is a method of thinking of ideas by "storming" the problem. To brainstorm in a group, everyone calls out any and all ideas that come to mind. Participants should not criticize themselves — hesitate about suggesting an idea — nor criticize others' ideas.

c. Tell students that they will have two minutes to think of as many ideas as they can for the following problem. Assign two fast writers to record the ideas on the board. Have the class begin as soon as you have read the problem.

Junked automobiles can be crushed and recycled. But most automobile tires are not recycled. They are thrown away as junk. What can be done with the millions of automobile and truck tires that are thrown away each year?

d. Stop after two minutes.

e. Record the total number of ideas generated for the junked tires problem on the board.

3. Rule two: think of wild and unusual ideas

a. Write rule two on the board:

2) Think of wild and unusual ideas

Explain that brainstorming works best when the group members are willing to suggest new and different ideas. Sometimes the strangest ideas turn out to be the best ones.

b. Assign the Oil Tank Problem. Have students read the problem description on page 21 of their Lesson Books. Begin whenever the class is ready. Record the ideas on the board. Remind the class of rule two. Brainstorm for two minutes.

c. Stop the class after two minutes.

d. Record the total number of ideas on the board.

4. Rule three: think of many, many ideas

a. Write rule three on the board:

3) Think of many, many ideas

Explain that when you list ideas, you usually think of common ideas first. If you keep trying, even after you think you've exhausted all of your ideas, sometimes the most unusual and best ideas come out.

b. Assign the Temporary Classrooms Problem. Have students read the problem description on page 21 of their Lesson Books. Brainstorm for one minute. Record the responses.

c. Stop the class when one minute has elapsed. Tell them that they will be able to return to this problem in a moment.

5. Rule four: hitchhike on others' ideas

a. Write rule four on the board:

4) Hitchhike on others' ideas

Explain that a hitchhike happens when one idea suggests another. A hitchhike may be an addition or an improvement on someone's idea or it may be a reversal of an idea.

b. Have students return to brainstorming ideas for the Temporary Classrooms Problem. Give them one additional minute.

c. On the board, record the total number of ideas generated for the Temporary Classrooms Problem. Compare the output for the three problems. Discuss the trend in terms of students' familiarization with brainstorming, the effect of the rules, and the difficulty of the problems.

6. Blocks and aids

a. Make two headings on the board — one for "blocks" and one for "aids."

b. Ask students to name any and all blocks that got in the way of thinking of ideas. Suggest "fear of criticism" or "fear of being laughed at" as possibilities. Other possible blocks include:
fear of being "wrong," lack of confidence, negative glances or sighs from others.

c. Ask students for suggestions of possible aids for thinking of ideas. "Picking up on the ideas of others" might be suggested. Other aids include:
using imagery (picturing the object being used in different ways in different places), thinking of humorous ideas, being willing to be a bit crazy, self-confidence.

d. *Optional.* Have students close their eyes and picture a local and well-known shopping district (shopping center, shopping mall). Have them begin at one end of the area and walk through it while imagining all the uses they can think of for used automobile tires. Have students continue to brainstorm until they have "walked" to the end of the district/mall.

7. Homework

Students should read pages 27-34 and complete all tasks assigned on these pages. This assignment is due for Lesson 7.

GROUPS

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Forming the groups. Form the groups using student responses to H-1 (Group Choice Form). Review page 22 in Lesson Book.	LB-22	5-10
2. Dramatization. Have five students prepare and dramatize the script on pages 23-26 in the Lesson Book. Have the remainder of the class evaluate the behaviors and strategies dramatized.	LB-23 to 26	15-25
3. Group review. Each group reaches consensus on evaluation notes.		5
optional break point		
4. Class review. Review students' evaluation notes.	LB-22	10
5. Group task. Students practice functioning as a group. Students brainstorm a problem given in the Teacher's Guide.		10-25
6. Homework. Students complete the assignment given at the end of Lesson 5.	LB-21	3

GROUPS

GOALS:

To form the class into groups;
To introduce group roles and strategies;
To provide for practice in positive group behaviors.

OBJECTIVES:

Students will be able to name group roles.
Students will be able to name group responsibilities.
Students will be able to evaluate a group problem-solving activity according to criteria.

MATERIALS:

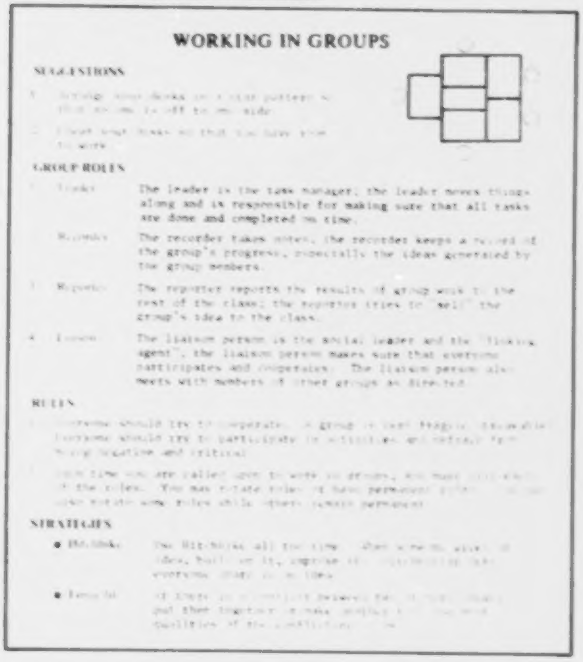
Lesson Books, notebooks, group rosters.

PREPARATION:

Read the reference section on "Groups" in this manual and Lesson Book pages 22-26. Have the group rosters ready.

DIRECTIONS:

1. Forming the groups



WORKING IN GROUPS

SUGGESTIONS

[illegible]

GROUP ROLES

1. Leader — The leader is the task manager; the leader moves things along and is responsible for making sure that all tasks are done and completed on time.
2. Recorder — The recorder takes notes; the recorder keeps a record of the group's progress, especially the ideas generated by the group members.
3. Reporter — The reporter reports the results of group work to the rest of the class; the reporter tries to "sell" the group's idea to the class.
4. Liaison — The liaison person is the social leader and the "linking agent"; the liaison person makes sure that everyone participates and cooperates. The liaison person also meets with members of other groups as directed.

RULES

[illegible]

STRATEGIES

[illegible]

a. Briefly remind students of their Group Choice Forms used in Lesson 2. Read the rosters. Have the students move to sit in their groups, rearranging desks if necessary. Explain that the groups as formed will remain the same until the end of the course unless unanticipated difficulties arise.

b. Point out that in any group there are certain tasks to be performed and roles to be played. Refer students to page 22 in the Lesson Book. Briefly discuss the suggestions, roles and rules listed. Reinforce their importance.

2. Dramatization

   a. Ask for five volunteers to dramatize the script on pages 23-26 in the Lesson Book. Send the volunteers to a corner of the room to prepare for the dramatization.

   b. Tell the rest of the students to write the heading "Groups" on a clean page of their notebooks, and to make two columns headed "positive" and "negative." Explain that they should make notes in these columns to evaluate the group performance they are about to see. Stress that students should not evaluate acting ability, but should try to identify positive behaviors that help group achievement and negative behaviors that get in the way of group achievement.

   c. Have the actors dramatize the script without interruption while the observers take notes.

3. Group review

   a. Have the actors return to their seats.

   b. Allow two or three minutes' group discussion to complete the evaluation notes. Encourage each group to try to reach consensus.

4. Class review

   a. Under the same headings used by the students, record students' evaluation comments on the board. Call on each group in turn. Collect and record all positive notes before asking for negative comments.

   Possible responses:

   Positive

   - *Problem as given was stated.*
   - *Challenges were given.*
   - *Broad terms statement made.*
   - *Good brainstorming performance.*
   - *The leader kept things moving.*
   - *The reporter kept notes and participated.*
   - *The liaison person and the leader tried to reduce criticism and have everyone participate.*
   - *The recorder did a good "sales job" at the end.*
   - *Everyone participated.*

   Negative

   - *The group forgot the term "explosion" and didn't use it well.*
   - *Not much mention of "the real problem."*
   - *Some criticism crept in.*
   - *Recorder was somewhat disorganized.*
   - *Some interruptions.*
   - *Some self-criticism (Wizard).*
   - *Reporter forgot part of the final idea.*

5. Group task

   a. Tell students that they will have five minutes to conduct a group brainstorming session.

   b. Have the groups quickly choose a leader, recorder, reporter and liaison person (temporary roles).

   c. Emphasize that the leader will be responsible for running the group; the recorder will be responsible for writing down all the ideas; the liaison person will be responsible for encouraging participation and discouraging criticism; and the reporter will be responsible for presenting the group's best idea.

   d. Read the following problem to the class:

      As you probably know, the President and the Congress have made a commitment for the United States to convert to the metric system over the next several years. This conversion is proving to be a very slow and difficult process. People, especially older people, seem very unwilling to give up their old ways and learn a new way. How might we find ways for people to learn and accept the metric system?

   e. Allow three to five minutes for brainstorming and five minutes or so for the reporters to give their reports.

   f. If time remains, ask the class to comment on positive and negative behaviors within the groups.

6. Homework

   Students should complete the tasks assigned at the end of Lesson 5 (Lesson Book pages 27-34).

THINKING OF IDEAS

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Review of brainstorming. Have students recall rules of brainstorming.		5-8
2. Checklist. Review the checklist technique and the "Taxi Checklist" assignment.	LB-28	5-15
3. Part-changing method. Review the method and "Improving My Classroom" assignment.	LB-30	10-20
4. Force fit. Review the force fit method and questions posed in the Lesson Book.	LB-32	10-20
optional break point		
5. Checkerboard. Review the checkerboard method and the task assigned in the Lesson Book.	LB-34	10-20
6. Practice on all three methods. Students work on exercises in class. Review and discuss.	H-4	10-25
7. Idea spinners. *(optional)* Have students construct idea spinners according to the directions on H-5. Set up a contest between the groups for practice.	H-5	10-25
8. Homework. Students should do the assignment on H-6 and read pages 35-37.	H-6 LB-35 to 37	3

THINKING OF IDEAS

GOALS:

To provide a review of brainstorming rules;
To provide for review of and practice with the methods: checklist, part changing and force fit.

OBJECTIVES:

Students will be able to define and explain the methods: checklist, part changing, and force fit.
Students will be able to use these methods on their own.

MATERIALS:

Lesson Books, notebooks, H-4 ("Practice Problems") and H-5 ("Make An Idea Spinner").

PREPARATION:

Read pages 27 to 34. Students should have read these pages and completed the tasks assigned on pages 28, 30, 32 and 34. Have students sit with their assigned groups.

DIRECTIONS:

1. Review of brainstorming

   a. Ask students to recall the rules of brainstorming. Write the rules on the board.

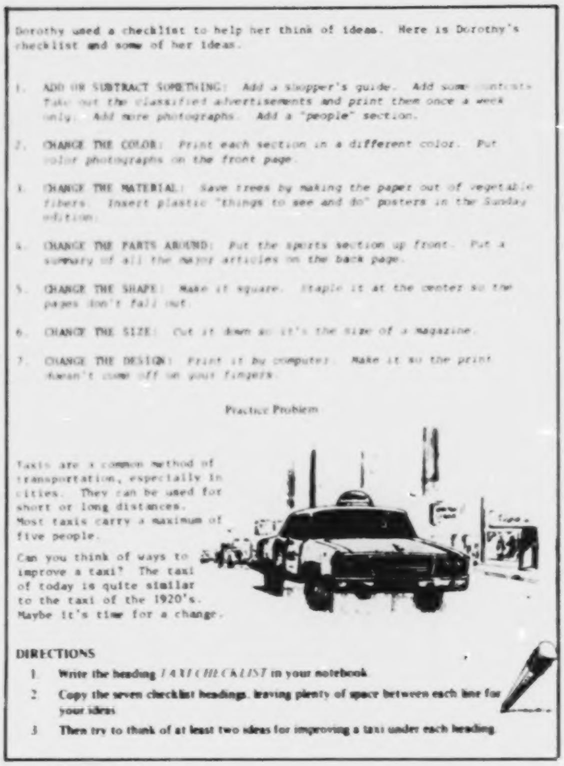
   b. Ask students to explain why they think each rule is necessary and important.

   c. Ask students to explain how the methods they read about for homework could help in brainstorming ideas.

3. Checklist

   a. Ask students to try to recall the parts of a checklist. Give one or two of the phrases to help them recall (e.g., "add or subtract something," "change the color").

   b. Have students turn to page 28 and to the page containing their "Taxi Checklist" in their notebooks. Ask for volunteers to give ideas for improving a taxi for each of the headings on the checklist. Continue until you think students have mastered the use of the method.



Dorothy used a checklist to help her think of ideas. Here is Dorothy's checklist and some of her ideas.

1. ADD OR SUBTRACT SOMETHING: *Add a shopper's guide. Add some contests. Take out the classified advertisements and print them once a week only. Add more photographs. Add a "people" section.*
2. CHANGE THE COLOR: *Print each section in a different color. Put color photographs on the front page.*
3. CHANGE THE MATERIAL: *Save trees by making the paper out of vegetable fibers. Insert plastic "things to see and do" posters in the Sunday edition.*
4. CHANGE THE PARTS AROUND: *Put the sports section up front. Put a summary of all the major articles on the back page.*
5. CHANGE THE SHAPE: *Make it square. Staple it at the center so the pages don't fall out.*
6. CHANGE THE SIZE: *Cut it down so it's the size of a magazine.*
7. CHANGE THE DESIGN: *Print it by computer. Make it so the print doesn't come off on your fingers.*

Practice Problem

Taxis are a common method of transportation, especially in cities. They can be used for short or long distances. Most taxis carry a maximum of five people.

Can you think of ways to improve a taxi? The taxi of today is quite similar to the taxi of the 1920's. Maybe it's time for a change.

DIRECTIONS

1. **Write the heading *TAXI CHECKLIST* in your notebook**
2. **Copy the seven checklist headings, leaving plenty of space between each line for your ideas**
3. **Then try to think of at least two ideas for improving a taxi under each heading**

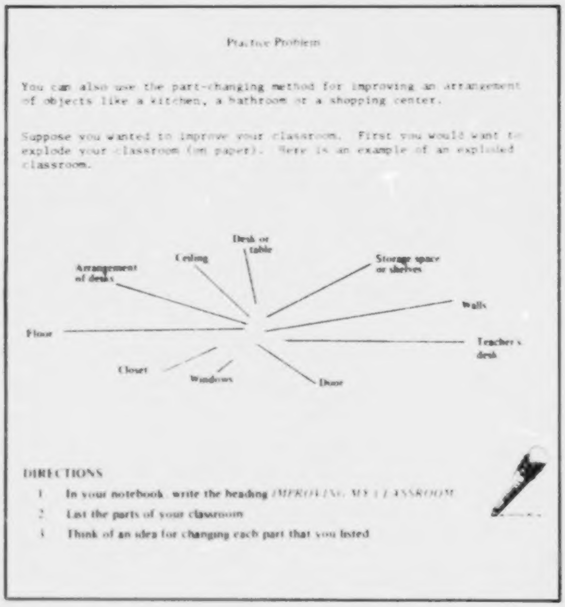
4. Part-changing method

   a. Select an object in the classroom that has two or more distinct parts to it (e.g., a globe, a jacket, an attaché case). Ask the class to name its parts. For each part, ask for an improvement idea.

   b. Ask the class to try to think of some inventions that weren't really inventions at all but were instances of the use of part changing — objects like touchtone telephones.

   c. Ask the class how the touchtone telephone is an example of the use of the part-changing method. Ask for other "inventions" that are instances of the part-changing method. Ask for explanations.

   d. Have students turn to page 30. Ask for part change ideas for each part of a classroom.



Practice Problem

You can also use the part-changing method for improving an arrangement of objects like a kitchen, a bathroom or a shopping center.

Suppose you wanted to improve your classroom. First you would want to explode your classroom (on paper). Here is an example of an exploded classroom.

Desk or table
Ceiling
Arrangement of desks
Storage space or shelves
Walls
Floor
Teacher's desk
Closet
Windows
Door

DIRECTIONS

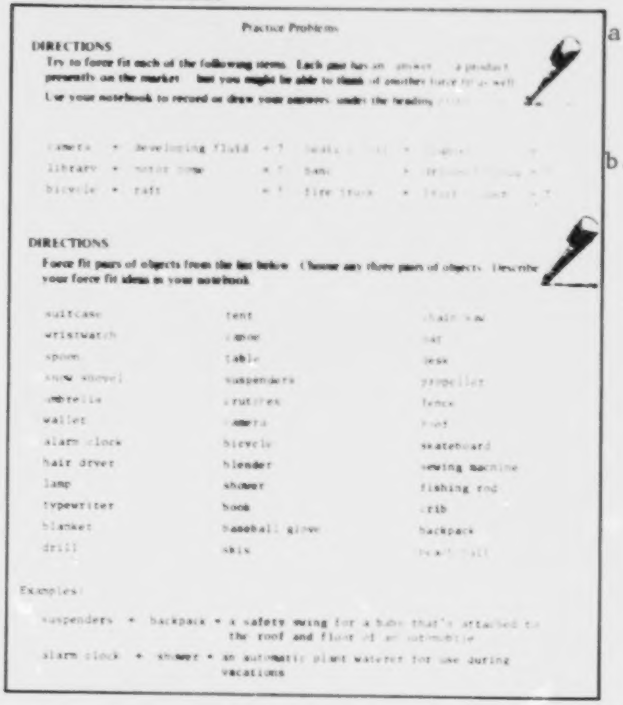
1. In your notebook, write the heading *IMPROVING MY CLASSROOM*
2. List the parts of your classroom
3. Think of an idea for changing each part that you listed

4. Force fit

a. Ask for an explanation of the force fit method. Ask for examples from the reading. Ask for other examples.

b. Review students' answers to the questions posed on page 32 of the Lesson Book. Suggested answers for the items at the top of the page:

- *Polaroid camera*
- *bookmobile*
- *paddle boat*
- *electric blanket*
- *drive-in bank*
- *fire truck with platform (cherry picker)*



Practice Problems

DIRECTIONS

Try to force fit each of the following items. Each pair has an answer — a product presently on the market — but you might be able to think of another force fit as well. Use your notebook to record or draw your answers under the heading [illegible]

camera + developing fluid = ? [illegible] + [illegible] = ?
library + motor home = ? bank + [illegible] = ?
bicycle + raft = ? fire truck + [illegible] = ?

DIRECTIONS

Force fit pairs of objects from the list below. Choose any three pairs of objects. Describe your force fit ideas in your notebook.

suitcase
wristwatch
spoon
snow shovel
umbrella
wallet
alarm clock
hair dryer
lamp
typewriter
blanket
drill

tent
canoe
table
suspenders
crutches
camera
bicycle
blender
shower
hook
baseball glove
skis

chain saw
cat
desk
propeller
fence
roof
skateboard
sewing machine
fishing rod
crib
backpack
beach ball

Examples:

suspenders + backpack = a safety swing for a baby that's attached to the roof and floor of an automobile

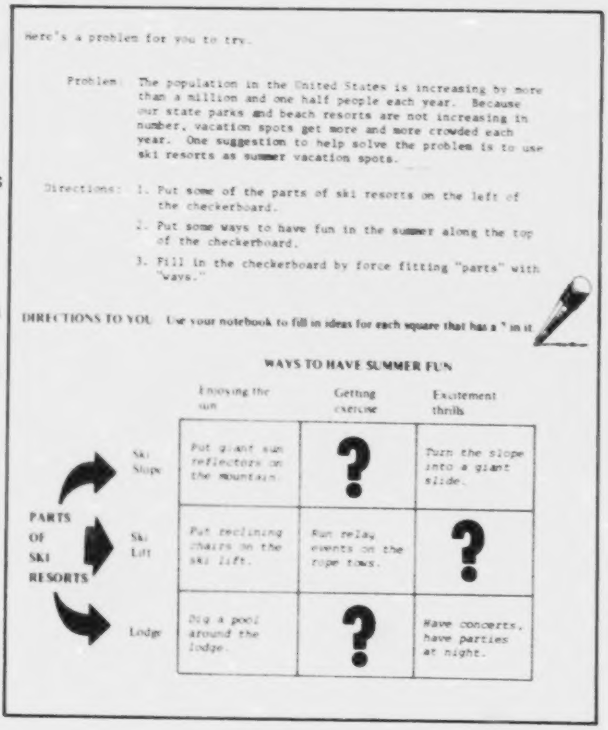
alarm clock + shower = an automatic plant waterer for use during vacations

5. Checkerboard

a. Ask for a volunteer to explain how the checkerboard works.

b. Review students' responses to the squares on page 34 that contain a question mark.

c. Point out that there are a large number of possible answers for each square in a checkerboard.



Here's a problem for you to try.

Problem: The population in the United States is increasing by more than a million and one half people each year. Because our state parks and beach resorts are not increasing in number, vacation spots get more and more crowded each year. One suggestion to help solve the problem is to use ski resorts as summer vacation spots.

Directions:
1. Put some of the parts of ski resorts on the left of the checkerboard.
2. Put some ways to have fun in the summer along the top of the checkerboard.
3. Fill in the checkerboard by force fitting "parts" with "ways."

DIRECTIONS TO YOU Use your notebook to fill in ideas for each square that has a ? in it.

WAYS TO HAVE SUMMER FUN

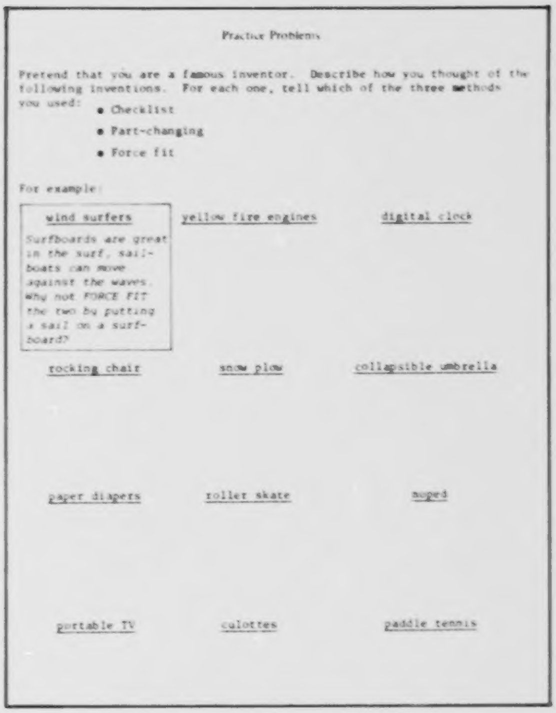
PARTS OF SKI RESORTS	Enjoying the sun	Getting exercise	Excitement thrills
Ski Slope	*Put giant sun reflectors on the mountain.*	?	*Turn the slope into a giant slide.*
Ski Lift	*Put reclining chairs on the ski lift.*	*Run relay events on the rope tows.*	?
Lodge	*Dig a pool around the lodge.*	?	*Have concerts, have parties at night.*

6. Practice on all three methods

   a. Have students turn to page H-4 and work alone to complete all of the exercises.

   b. Have students who finish early, and then all students, compare answers with other group members.

   c. Ask for volunteers to read their responses.



Practice Problems

Pretend that you are a famous inventor. Describe how you thought of the following inventions. For each one, tell which of the three methods you used:

- Checklist
- Part-changing
- Force fit

For example:

wind surfers

Surfboards are great in the surf, sailboats can move against the waves. Why not FORCE FIT the two by putting a sail on a surfboard?

yellow fire engines

digital clock

rocking chair

snow plow

collapsible umbrella

paper diapers

roller skate

moped

portable TV

culottes

paddle tennis

7. Idea spinners *(Optional)*

   a. Have students construct idea spinners according to the directions on page H-5.

      Note: Students will need paper fasteners for this task. Bent paper clips can also be used.

   b. Set up a contest between groups. Give a prescribed amount of time for students to generate ideas for changing (improving) the following objects. Request that students use their idea spinners to suggest ideas.

      - *skateboards*
      - *record album*
      - *textbook*
      - *bed*

   c. Stop the class. Give an additional amount of time to construct force fits from the ideas they have already produced.

   d. Stop the class. Ask for the total number of ideas generated by each group. Ask for each group's best idea for each object.

8. Homework

   Students should do the assignment on page H-6. Students should also read pages 35-37 in their Lesson Books and follow the directions given on page 37.

JUDGING IDEAS

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Homework review. Review of students' responses to H-6.	H-6	5-15
2. Criterion, criteria — introduction. Define and explain terms.		5-8
3. Criteria — practice. Students generate a list of criteria appropriate to the evaluation of a a childproof medicine cabinet.		10-15
4. Using criteria. Students use H-7 to rate the "fire streets" idea given in the Lesson Book. Students brainstorm additional ideas, rate them, then report to the class on their ratings.	LB-37 H-7	15-30
5. Homework. Students should read pages 38-48.	LB-38 to 48	5

Unit I
Lesson 8

JUDGING IDEAS

GOALS:

To introduce the evaluation stage of problem solving;
To teach a technique for rating solution ideas according to appropriate criteria.

OBJECTIVES:

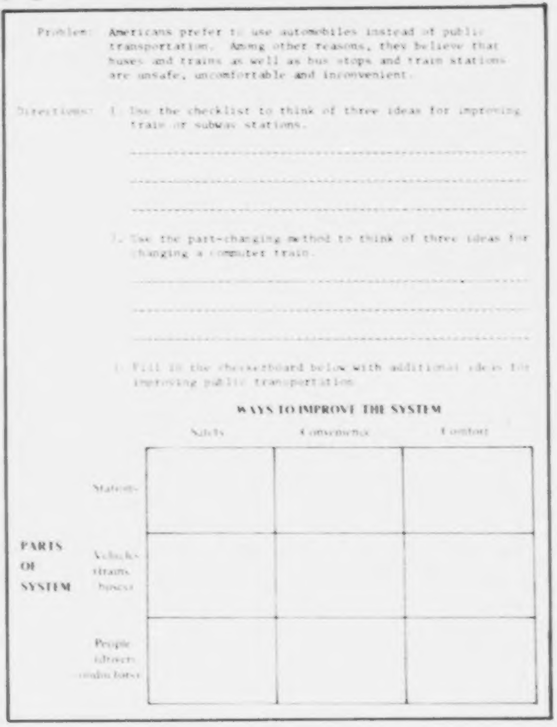
Students will be able to define the word criteria and explain their purpose.
Students will be able to select and/or generate criteria for evaluating ideas.
Students will be able to construct and use a sample rating system for evaluating ideas.

MATERIALS:

Lesson Books, notebooks, H-7 ("Judging Ideas").

PREPARATION:

Read pages 35 to 37. Students should have read pages 35-37 and completed the assignment given on page 37 as well as the exercises on page H-6.



Problem: Americans prefer to use automobiles instead of public transportation. Among other reasons, they believe that buses and trains as well as bus stops and train stations are unsafe, uncomfortable and inconvenient.

Directions: 1. Use the checklist to think of three ideas for improving train or subway stations.

----

2. Use the part-changing method to think of three ideas for changing a commuter train.

----

3. Fill in the checkerboard below with additional ideas for improving public transportation.

WAYS TO IMPROVE THE SYSTEM

		Safety	Convenience	Comfort
PARTS OF SYSTEM	Stations			
	Vehicles (trains, buses)			
	People (drivers, conductors)			

DIRECTIONS:

1. Homework review
    a. Review students' responses to the tasks assigned on page H-6.
    b. Ask for a volunteer to describe a possible public transportation system of the future using his or her checklist.
    c. Ask for hitchhikes on the ideas presented.

2. Criterion, criteria — introduction

   a. Have students consider what they would do to help a friend select a ten-speed bicycle. Ask:

      What kinds of things would you recommend that your friend consider in choosing among the bikes on the market?

      Here are some possible answers:

      - *Cost*
      - *Weight*
      - *Availability of parts and service*
      - *Guarantee*
      - *Strength*
      - *Size (frame, tires)*
      - *Equipment, extras available*
      - *Type of gears*
      - *Color*
      - *Quality (or reputation of manufacturer)*

   b. Ask students what these "things" are called. Point out that they are called criteria. Any one of them is called a criterion.

      Definition: Things (or values, standards) that are important for judging something. *You may want to write this definition on the board.*

3. Criteria — practice

   a. Give students the following problem:

      Suppose you have been assigned to judge a competition. People from all over the country have sent in their ideas for building a childproof medicine cabinet for bathrooms. What criteria could you use for evaluating these ideas?

   b. Ask for suggestions.

   c. Write each distinct criterion on the board. Redefine if necessary. Use the phrases and examples below as needed.

      Please note: The criteria below will be repeated in this and later lessons but should not be treated as definitive. Depending upon the problem and the values of the evaluator, criteria will change, be dropped, and be added. In addition, students may wish to assign differential weights to criteria.

      WORKABILITY: Will it work, will it solve the problem? (includes strength, durability)
      Putting a "don't touch" sign on the cabinet will solve the problem for very few children.

      COST: Will it be too expensive?
      Wiring the cabinet with an alarm and a tape player that would say "no-no, don't touch" would be too expensive.

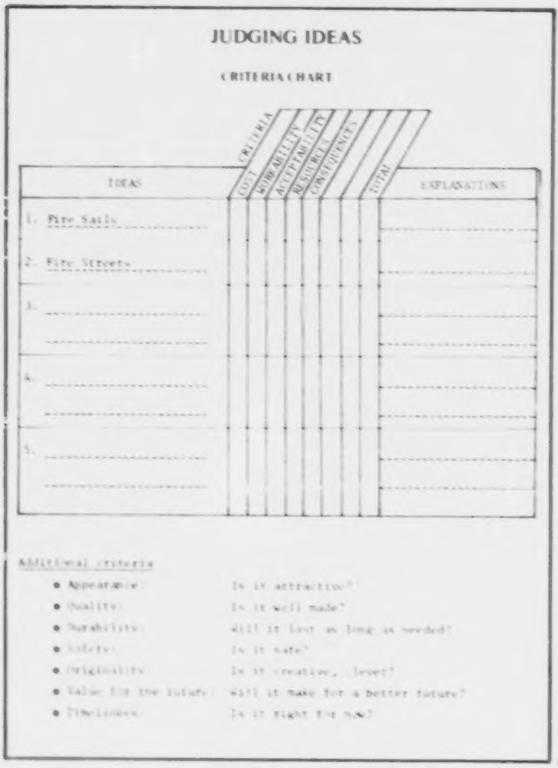
ACCEPTABILITY: Will people want it, accept it, use it? (includes accessibility)
Putting a combination lock or padlock on the door would probably be unacceptable to most homeowners.

RESOURCES: Are the resources or materials available? (includes practicality)
Someone might think of mirrored doors that would flash a picture of a scolding parent whenever a child comes near it -- a good idea but the resources are not available.

CONSEQUENCES: Will it produce undesirable consequences? (includes safety)
Heavy, hard-to-open doors might not be useable by some adults; complicated latches and buttons may be a problem in an emergency.

4. Using criteria

a. Have students open their Lesson Books to page 37 and take out page H-7, the handout labeled "Judging Ideas."



JUDGING IDEAS

CRITERIA CHART

IDEAS	COST	WORKABILITY	ACCEPTABILITY	RESOURCES	CONSEQUENCES		TOTAL	EXPLANATIONS
1. Fire Sails								
2. Fire Streets								
3.								
4.								
5.								

Additional criteria

- Appearance: Is it attractive?
- Quality: Is it well made?
- Durability: Will it last as long as needed?
- Safety: Is it safe?
- Originality: Is it creative, clever?
- Value for the future: Will it make for a better future?
- Timeliness: Is it right for now?

b. Have the groups discuss and fill out the criteria chart for the "fire streets" idea presented on page 37. The criteria chart is on page H-7. You may wish to give students extra time to read pages 35-37 or you may want to review these pages with them.

c. Call on members of the different groups to report on how they rated the "fire streets" idea according to each of the criteria. Help the class to understand each criterion and to reach a consensus (there are no correct answers).

d. Have the groups brainstorm additional ideas for fighting forest fires. Give them three to four minutes for brainstorming.

e. Have the groups record and rate their best ideas on the criteria chart on page H-7.

f. *Optional:* With just five criteria and a simple pass vs. fail rating, ties may occur. Since students will be using criteria charts in later lessons, you may wish to teach one of the following tie-breaking methods:

1) Instead of rating each idea as a P or an F, give each idea a numerical rating (e.g., 0-4) for each criterion.

2) Rank the importance of each of the criteria on a scale of 1 to 5 before rating your ideas. Give each F a score of 0 and each P a score of 1. Multiply the pass-fail score for each criterion by the weight assigned to that criterion. Add up the totals for each criterion for a grand total for that idea.

3) Use a combination of 1 and 2.

g. Have the groups report on the results of their evaluation. Encourage the reporters to mention:

- Number of ideas produced
- Additional criteria used
- Rating system used
- Reasons for "F" ratings
- Best idea and why

5. Homework

Students should read pages 38-48 for the next class session. Explain that in the next lesson period they will be using handouts that match those pages read, but which focus on a different problem and do not have any "answers" on them. Students should pay careful attention to the sequence and content of each numbered task and to the symbols indicating when work is done individually or in groups.

SEESAW

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Introduction.		3-5
2. Beginning the lesson. Clarification of task.	H-8 to H-16	two to five class periods
3. Maintaining productivity.		
4. Group reports.		
5. Homework. Students read and respond to pages 51-61 in their Lesson Books.		5-10

SEESAW

GOALS:

To provide for an integration of all previously learned problem-solving steps and techniques in a guided group and individual problem-solving task.

OBJECTIVES:

Students will be able to use each of the learned techniques with minimal guidance.
Groups will be able to plan and carry out a problem-solving sequence with minimal guidance.

MATERIALS:

Lesson Books, notebooks, H-8 to H-16 ("B pages").

PREPARATION:

Students should have read pages 38-48 in their Lesson Books.

DIRECTIONS:

1. Introduction
   a. Arrange students in their groups.
   b. Have the groups select students for group roles.
   c. Tell students that they will be responsible for solving a problem. The lesson will take more than one class period.
   d. Although students will have all the time they need, they should be told to work rapidly and efficiently.
2. Beginning the lesson
   a. Show students how to place the "A" pages next to the "B" pages.
   b. Call students' attention to the figures in the left-hand margin.
      - Single figure: Work alone
      - Two figures: Choose a partner
      - Five figures: Whole group
   c. Remind the group leaders to keep the group working at an efficient pace.
   d. Have students begin reading section B-1. Point out that students should feel free to ask for assistance whenever they need it and to move from one section to the next at their own speed.

3. Maintaining the productivity of the lesson

Students should be able to proceed through all the steps with only an occasional need for guidance or assistance. The lesson should take anywhere from two to five class periods.

You may wish to copy the time estimates from the Lesson Summary page on the board, or help students to pace themselves in some other way.

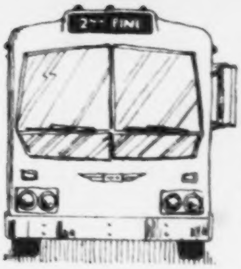
4. Group reports

Students are directed to prepare a report to the class in section B-14. You may wish to structure this report in advance by having students respond to any or all of the following:

- Our problem statement
- Our best idea
- How we thought of this idea
- What improvements we made on our original idea
- How it meets all the criteria we selected

5. Homework

Unit II--Futures Studies--begins with Lesson 10. Before that lesson, students should have read pages 51-61 in their Lesson Books and completed the tasks assigned on these pages. It is advisable to set this assignment 2 to 3 days before Lesson 10.

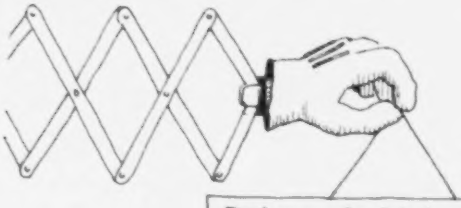


Design a bus that would hold more people than present buses and would be easier to enter and leave.

MAKE 3 TRIANGLES WITH 6 MATCHES

THINK OF TEN USES FOR:

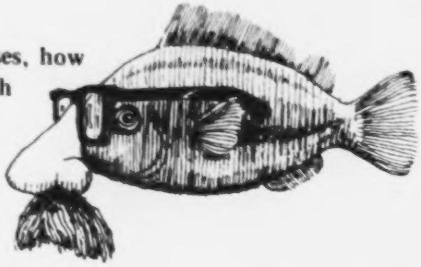
A. OLD AIRPLANES
B. OLD WARSHIPS
C. OLD MATTRESSES

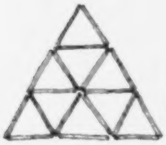


Design a wheelchair attachment for opening doors.

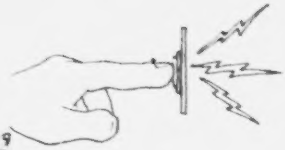
Design a revolving door for wheelchairs

Aside from disguises, how can we protect fish from overfishing?

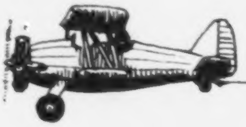




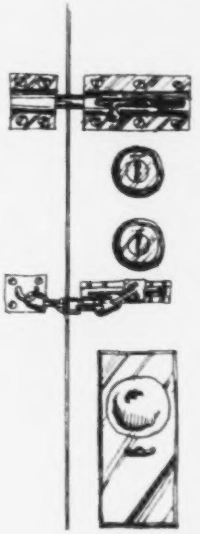
Remove five sticks so that four triangles remain.



DESIGN A 'DOORBELL' FOR THE DEAF



DESIGN A PLANT WATERING MACHINE



DESIGN A SAFE APARTMENT HOUSE

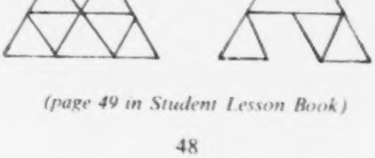
For ten seconds, try not to think about hamburgers.

Design baby clothes that will grow with the baby.

DESIGN A NUTCRACKER THAT WON'T CRUSH THE NUT

Answers to the puzzles:

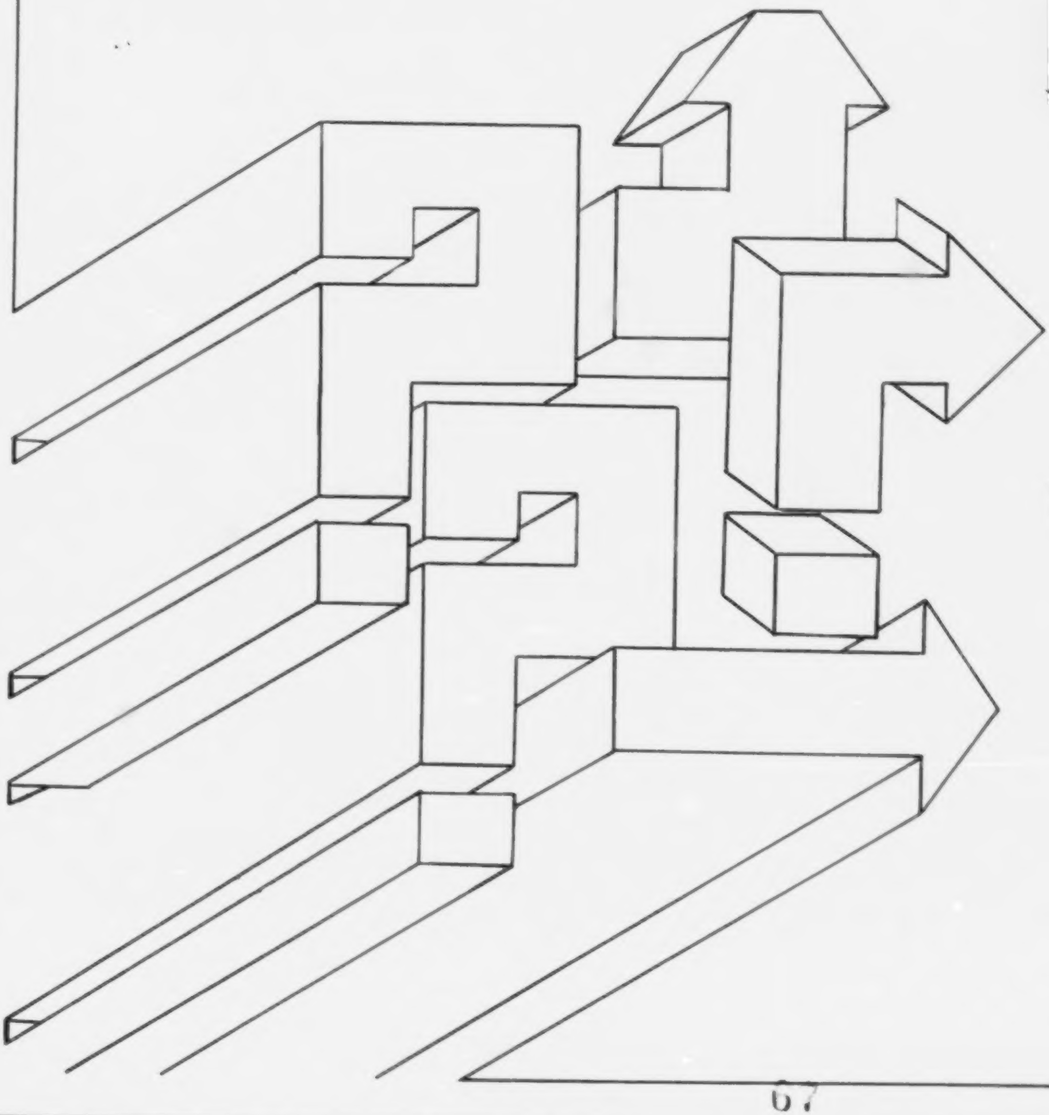
- **The match problem.** The solution is to think in three dimensions. Make a triangle with three matches, then construct a pyramid over that triangle with the remaining matches.
- **The four triangles problem.** The solution is to realize that there are different sized triangles in the figure. One solution is as follows:



(page 49 in Student Lesson Book)

MAKING CHANGES

a futures-oriented course in inventive problem solving

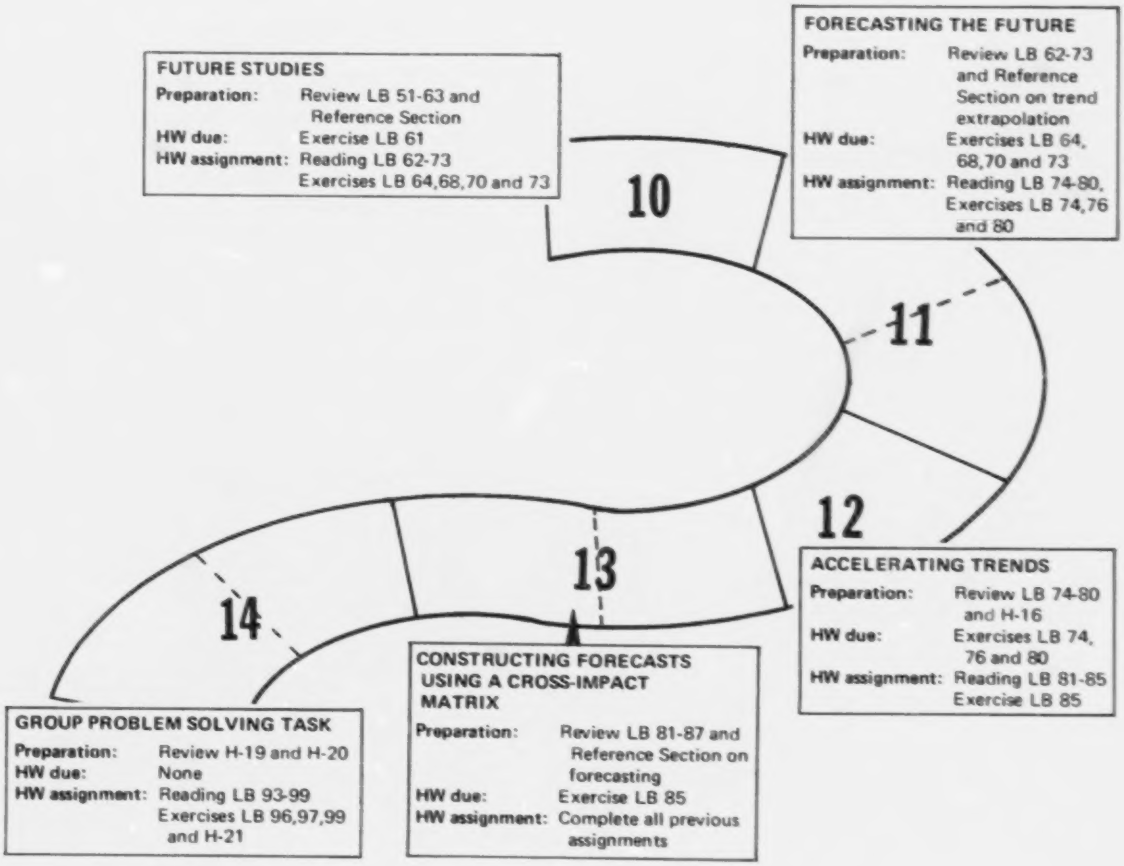


Unit
II

etc

CALENDAR AND HOMEWORK SUMMARY

UNIT II



FUTURE STUDIES

Preparation: Review LB 51-63 and Reference Section

HW due: Exercise LB 61

HW assignment: Reading LB 62-73
Exercises LB 64,68,70 and 73

FORECASTING THE FUTURE

Preparation: Review LB 62-73 and Reference Section on trend extrapolation

HW due: Exercises LB 64, 68,70 and 73

HW assignment: Reading LB 74-80, Exercises LB 74,76 and 80

ACCELERATING TRENDS

Preparation: Review LB 74-80 and H-16

HW due: Exercises LB 74, 76 and 80

HW assignment: Reading LB 81-85
Exercise LB 85

CONSTRUCTING FORECASTS USING A CROSS-IMPACT MATRIX

Preparation: Review LB 81-87 and Reference Section on forecasting

HW due: Exercise LB 85

HW assignment: Complete all previous assignments

GROUP PROBLEM SOLVING TASK

Preparation: Review H-19 and H-20

HW due: None

HW assignment: Reading LB 93-99
Exercises LB 96,97,99 and H-21

FUTURES STUDIES

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Homework review. Teacher-led review of students' responses to the questions on page 61 of the Lesson Book.	LB-61	10-15
2. Ideas on the future. Students discuss implications of the possible developments listed on pages 57-60.	LB-57 to 60	10-15
3. What's an ecotect? Students work in twos or threes to fill in possible future jobs.	H-17	10-15
4. Homework. Students are asked to read pages 62-73 in the Lesson Book and to complete the tasks assigned in those pages.	LB-62 to 73	5

FUTURES STUDIES

GOALS:

To reinforce the "rationale" for futures studies introduced in the homework reading;
To give students the opportunity to apply concepts of futures studies to their own futures.

OBJECTIVES:

Students will be able to explain the importance of each of the four reasons for studying the future.
Given a number of topics, students will be able to name at least a half dozen alternatives for the future and to discuss their implications.

MATERIALS:

Lesson Books, notebooks, H-17 ("What's an Ecotect?").

PREPARATION:

Read the "Future Studies" material, pages 51-61 in the Lesson Book and skim the Reference Section headed "Forecasting Methods." Students should have read pages 51-61 and completed the written assignment on page 61.

DIRECTIONS:

1. Homework review

Review answers to the eight questions posed on page 61.
Suggested answers:

Question 1. *The "s" is used in order to keep in mind that there is no single future; there are alternative futures.*

Question 2. *There is no correct answer. Encourage a short discussion on this question. Ask for reasons in support of a view. Ask for alternative descriptions (similes).*

Question 3. *Encourage definitions that use synonyms for "possible" or "alternative" rather than definitions that imply special powers as in the ability to foresee or predict.*

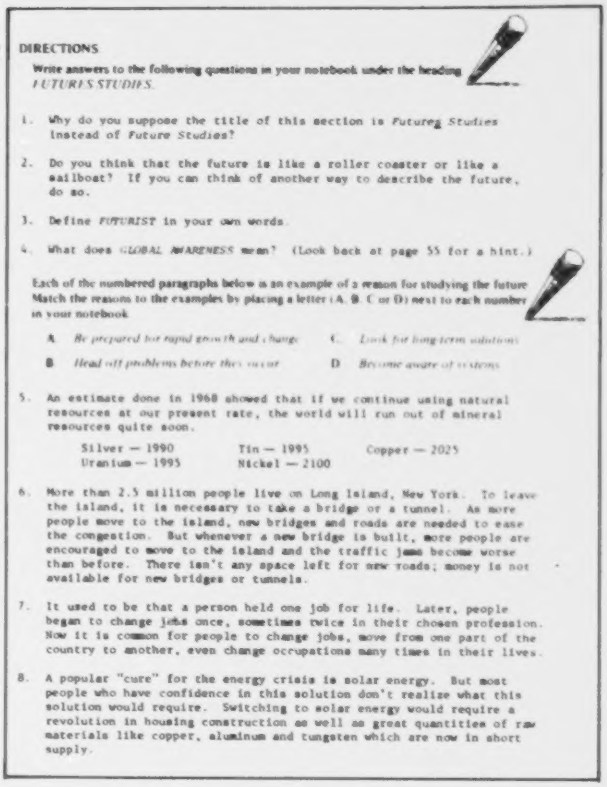
Question 4. *Students' answers should contain more than "know about other countries." The best answers will specify the interdependence or interconnectedness of events, policies, and decisions.* Ask for examples of the need for global awareness.

Question 5. *The best answer is probably "to head off problems before they occur." But any of the other reasons should be accepted if well justified.*

Question 6. *The best answer is probably "to look for long-term solutions." But again, any of the others, especially the second reason, could be acceptable.*

Question 7. *The best answer is "to become prepared for rapid growth and change."*

Question 8. *The best answer might be "to become aware of systems -- how things are connected to one another" but, "long-term solutions" is equally acceptable.*



DIRECTIONS

Write answers to the following questions in your notebook under the heading *FUTURES STUDIES*.

1. Why do you suppose the title of this section is *Futures Studies* instead of *Future Studies*?
2. Do you think that the future is like a roller coaster or like a sailboat? If you can think of another way to describe the future, do so.
3. Define *FUTURIST* in your own words.
4. What does *GLOBAL AWARENESS* mean? (Look back at page 55 for a hint.)

Each of the numbered paragraphs below is an example of a reason for studying the future. Match the reasons to the examples by placing a letter (A, B, C or D) next to each number in your notebook.

A *Be prepared for rapid growth and change*

B *Head off problems before they occur*

C *Look for long-term solutions*

D *Become aware of systems*

5. An estimate done in 1968 showed that if we continue using natural resources at our present rate, the world will run out of mineral resources quite soon.

   Silver — 1990 Tin — 1995 Copper — 2025
   Uranium — 1995 Nickel — 2100

6. More than 2.5 million people live on Long Island, New York. To leave the island, it is necessary to take a bridge or a tunnel. As more people move to the island, new bridges and roads are needed to ease the congestion. But whenever a new bridge is built, more people are encouraged to move to the island and the traffic jams become worse than before. There isn't any space left for new roads; money is not available for new bridges or tunnels.
7. It used to be that a person held one job for life. Later, people began to change jobs once, sometimes twice in their chosen profession. Now it is common for people to change jobs, move from one part of the country to another, even change occupations many times in their lives.
8. A popular "cure" for the energy crisis is solar energy. But most people who have confidence in this solution don't realize what this solution would require. Switching to solar energy would require a revolution in housing construction as well as great quantities of raw materials like copper, aluminum and tungsten which are now in short supply.

2. Ideas on the future

Pages 57-60 present possibilities for the future organized under a series of headings. Each was selected from a reputable source and each can be considered to be a forecast. However, each forecast is an alternative, a selection from a number of possibilities. You and your students may find that some seem more likely than others and some are more desirable than others.

a. Have students turn to pages 57-60 and look for an example of a forecast that has already come to be, at least in part *(e.g., the Housing forecasts and Commerce "a").*

b. Have students look for the forecast that they think is most unlikely. Ask for an explanation in terms of other trends. Have students make an alternative forecast.

c. Have students look for a forecast that they believe would be undesirable. Ask for explanations. Ask for alternative ways of solving the problem that the forecast is addressed to.

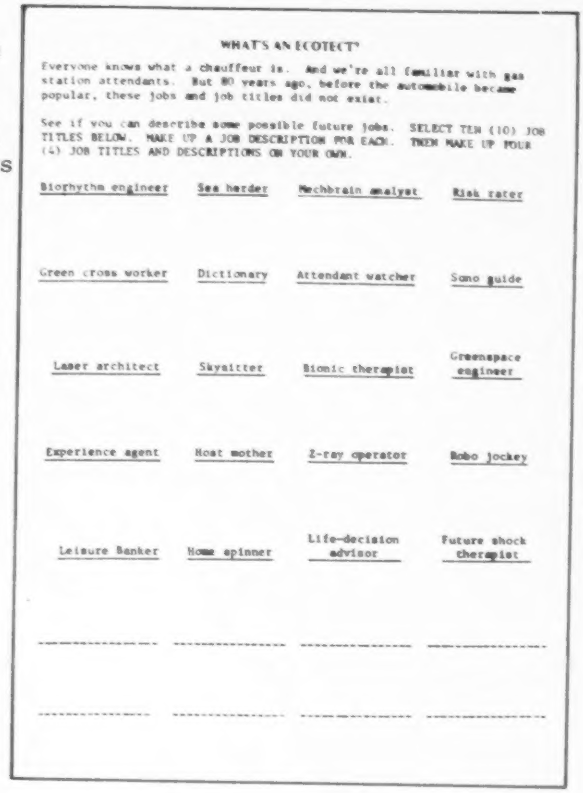
d. Have students look for problems and negative consequences that might follow if a selected forecast were to come true.

3. What's an ecotect?

   Have students take out page H-17 and begin filling in their ideas for the hypothetical future jobs listed on this page. Have students work in twos or in threes.

4. Homework

   Before the next lesson, students should read pages 62-73 in their Lesson Books and write responses to the questions posed on pages 64, 68, 70 and 73.



WHAT'S AN ECOTECT?

Everyone knows what a chauffeur is. And we're all familiar with gas station attendants. But 80 years ago, before the automobile became popular, these jobs and job titles did not exist.

See if you can describe some possible future jobs. SELECT TEN (10) JOB TITLES BELOW. MAKE UP A JOB DESCRIPTION FOR EACH. THEN MAKE UP FOUR (4) JOB TITLES AND DESCRIPTIONS ON YOUR OWN.

Biorhythm engineer	Sea herder	Mechbrain analyst	Risk rater
Green cross worker	Dictionary	Attendant watcher	Sono guide
Laser architect	Skysitter	Bionic therapist	Greenspace engineer
Experience agent	Host mother	Z-ray operator	Robo jockey
Leisure Banker	Home spinner	Life-decision advisor	Future shock therapist

FORECASTING THE FUTURE

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Homework review. Teacher-led review of students' responses to questions posed on pages 64, 68 and 70.	LB-64, 68 and 70	10-25
optional break point		
2. Railroad futures. Students discuss their responses to questions posed on page 73.	LB-73	15-20
3. Group reports.	LB-73	8-10
4. Homework. Students read pages 74-80 in the Lesson Book and complete the tasks assigned in those pages.	LB-74 to 80	5

FORECASTING THE FUTURE

GOALS:

To review and reinforce students' ability to evaluate forecasts according to given criteria;
To give students the opportunity to share their opinions and demonstrate their comprehension of forecasts and forecasting methods through group discussion.

OBJECTIVES:

Students will be able to name and define the four criteria used to judge forecasts.
Given several forecasts of different types, students will be able to identify those which fail to meet a given criterion.
Students will be able to identify: Forecasts based on trends; Delphi forecasts; forecasts made by individuals.
Students will be able to interpret a variety of graphed trends.
Students will demonstrate their understanding of how a variety of relevant factors could influence a given trend by selecting appropriate responses from a list.
Students will be able to construct a forecast and justify it by presenting appropriate evidence.

MATERIALS:

Lesson Books, notebooks, and group notebooks.

PREPARATION:

Read pages 62-73 in the Lesson Book and the section headed "Trend Extrapolation" in the Reference Section. Students should have read pages 62-73 and completed the written assignments presented on pages 64, 68, 70 and 73.

DIRECTIONS:

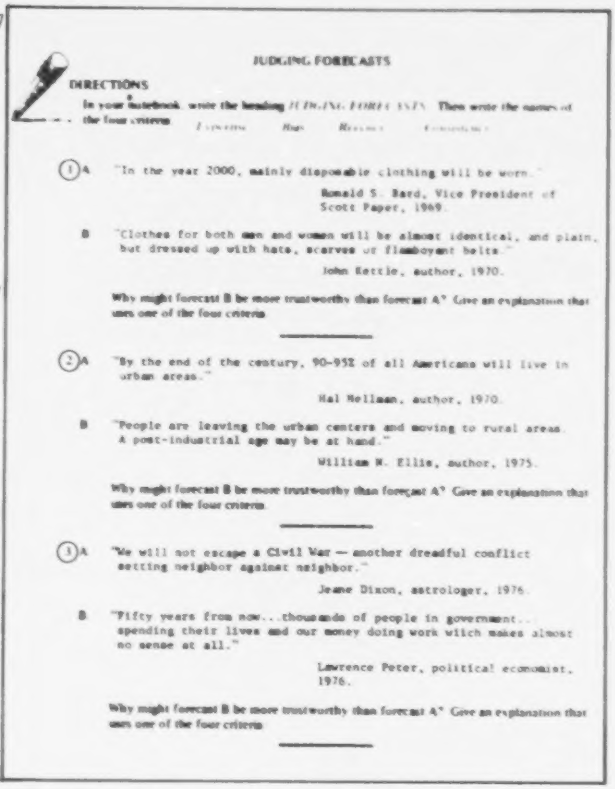
I. Homework review

a. Have students open their notebooks to "Judging Forecasts" and their Lesson Books to page 64. Review responses. Suggested answers:

1) *Forecast B is probably more trustworthy than Forecast A because there is reason to believe that Mr. Bard would have something to gain if his forecast came true. He is probably biased.*

2) *Forecast B is probably more trustworthy than Forecast A because it is more recent. All things being equal, recent, up-to-date forecasts are more reliable if they take into account recent events and trends.*

3) *Forecast B is probably more trustworthy than Forecast A because Lawrence Peter can be considered to be more of an expert than Jeane Dixon.*



JUDGING FORECASTS

DIRECTIONS

In your notebook, write the heading *JUDGING FORECASTS.* **Then write the names of the four criteria.** *Expertise   Bias   Recency   Consistency*

① A "In the year 2000, mainly disposable clothing will be worn."

Ronald S. Bard, Vice President of Scott Paper, 1969.

B "Clothes for both men and women will be almost identical, and plain, but dressed up with hats, scarves or flamboyant belts."

John Kettle, author, 1970.

Why might forecast B be more trustworthy than forecast A? Give an explanation that uses one of the four criteria.

② A "By the end of the century, 90-95% of all Americans will live in urban areas."

Hal Hellman, author, 1970.

B "People are leaving the urban centers and moving to rural areas. A post-industrial age may be at hand."

William N. Ellis, author, 1975.

Why might forecast B be more trustworthy than forecast A? Give an explanation that uses one of the four criteria.

③ A "We will not escape a Civil War — another dreadful conflict setting neighbor against neighbor."

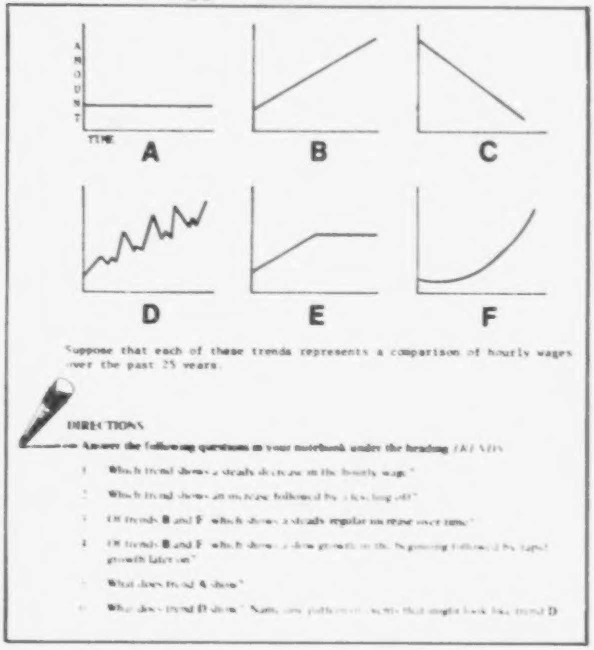
Jeane Dixon, astrologer, 1976.

B "Fifty years from now...thousands of people in government... spending their lives and our money doing work which makes almost no sense at all."

Lawrence Peter, political economist, 1976.

Why might forecast B be more trustworthy than forecast A? Give an explanation that uses one of the four criteria.

b. Briefly review students' responses to questions posed on page 68. Suggested answers:



Suppose that each of these trends represents a comparison of hourly wages over the past 25 years.

DIRECTIONS

Answer the following questions in your notebook under the heading *TRENDS*

1. Which trend shows a steady decrease in the hourly wage?
2. Which trend shows an increase followed by a leveling off?
3. Of trends B and F, which shows a steady regular increase over time?
4. Of trends B and F, which shows a slow growth in the beginning followed by rapid growth later on?
5. What does trend A show?
6. What does trend D show? Name one pattern of events that might look like trend D.

1) *Trend C (shows a steady decrease).*

2) *Trend E (shows an increase then a leveling off).*

3) *Trend B (shows a steady increase).*

4) *Trend F (shows a slow increase and then rapid growth).*

5) *Trend A shows no change — a continuous level.*

6) *Trend D shows an overall increase with many fluctuations. Events that may have this trend pattern include: stock market prices, a seasonal graph of park attendance, number of absences from school for each day in June.*

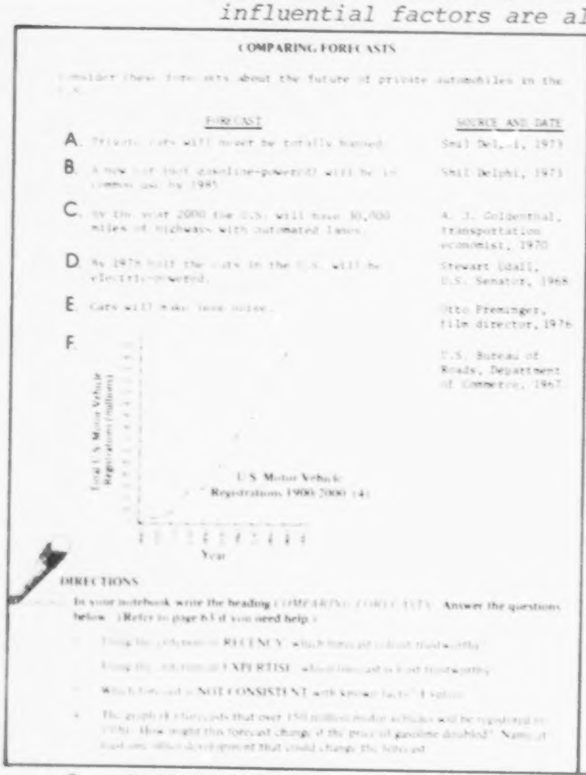
c. Have students open their notebooks to "Comparing Forecasts" and their Lesson Books to page 70. Review responses. Suggested answers:

1) *Forecast F is least recent. It was made by the U.S. Bureau of Roads in 1967.*

2) *Forecast E scores lowest on expertise. It was made by a movie director who may or may not have been in a "position to know" at the time of the forecast.*

3) *Forecast D. Current events do not support this statement.*

4) *If the price of gasoline doubled, the number of registered vehicles might decrease. Any or all of the following could affect forecast F: Changes in the size of the population; changes in per capita income; improved mass transit; strictly enforced pollution laws; a decrease in the availability of gasoline; increased production of a "new" kind of car. Other influential factors are also possible.*



COMPARING FORECASTS

Consider these forecasts about the future of private automobiles in the U.S.

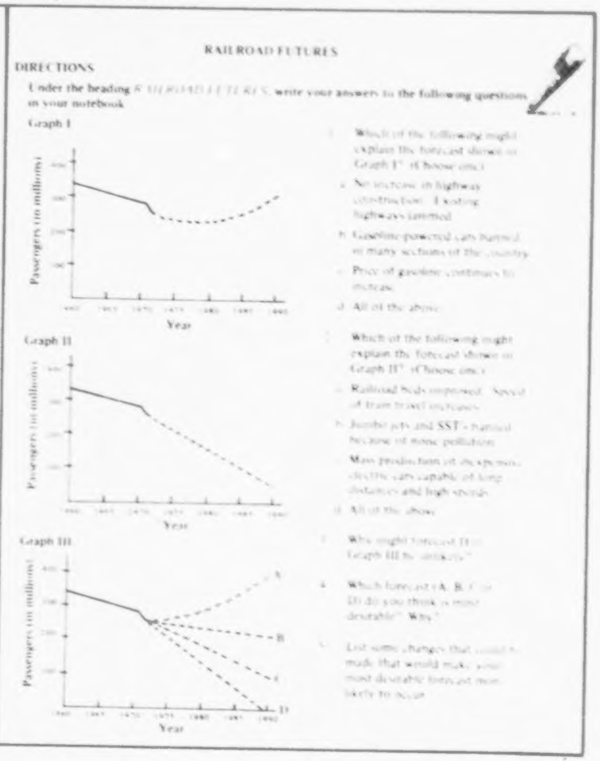
FORECAST	SOURCE AND DATE
A. Private cars will never be totally banned.	Smil Delphi, 1973
B. A new (not just gasoline-powered) car will be in common use by 1985.	Smil Delphi, 1973
C. By the year 2000 the U.S. will have 30,000 miles of highways with automated lanes.	A. J. Goldenthal, transportation economist, 1970
D. By 1978 half the cars in the U.S. will be electric-powered.	Stewart Udall, U.S. Senator, 1968
E. Cars will make less noise.	Otto Preminger, film director, 1976
F.	U.S. Bureau of Roads, Department of Commerce, 1967

Total U.S. Motor Vehicle Registrations (millions)
U.S. Motor Vehicle Registrations 1900-2000 (4)
Year

DIRECTIONS

In your notebook write the heading COMPARING FORECASTS. Answer the questions below. (Refer to page 63 if you need help.)

1. Using the criterion of RECENCY, which forecast is least trustworthy?
2. Using the criterion of EXPERTISE, which forecast is least trustworthy?
3. Which forecast is NOT CONSISTENT with known facts? Explain.
4. The graph (F) forecasts that over 150 million motor vehicles will be registered in 1990. How might this forecast change if the price of gasoline doubled? Name at least one other development that could change the forecast.



RAILROAD FUTURES

DIRECTIONS

Under the heading RAILROAD FUTURES, write your answers to the following questions in your notebook.

Graph I

Passengers (in millions)
400
300
200
100
1960
1965
1970
1975
1980
1985
1990
Year

Graph II

Passengers (in millions)
400
300
200
100
1960
1965
1970
1975
1980
1985
1990
Year

Graph III

Passengers (in millions)
400
300
200
100
A
B
C
D
1960
1965
1970
1975
1980
1985
1990
Year

1. Which of the following might explain the forecast shown in Graph I? (Choose one.)
   - a. No increase in highway construction. Existing highways jammed.
   - b. Gasoline-powered cars banned in many sections of the country.
   - c. Price of gasoline continues to increase.
   - d. All of the above.
2. Which of the following might explain the forecast shown in Graph II? (Choose one.)
   - a. Railroad beds improved. Speed of train travel increases.
   - b. Jumbo jets and SST's banned because of noise pollution.
   - c. Mass production of inexpensive electric cars capable of long distances and high speeds.
   - d. All of the above.
3. Why might forecast D in Graph III be unlikely?
4. Which forecast (A, B, C or D) do you think is most desirable? Why?
5. List some changes that could be made that would make your most desirable forecast more likely to occur.

2. Railroad futures

a. Have the students sit in their groups. Explain that within each group, students should discuss their responses to the questions on page 73 of the Lesson Book. Group agreement should be reached on the answer to each question, which then should be recorded in the group notebook. Special attention should be given to the questions relating to Graph III showing four alternative futures. Each group will be expected to make a report to the class.

b. As the students get to work, wirte the following on the board:

Group Reports

1) *Report your answers to the questions on page 73.*

2) *Explain your choices for the most likely and most desirable railroad futures.*

3) *List those changes that might make your most desirable forecast more likely to occur.*

4) *List those things that would change if your most desirable railroad future came true.*

c. Direct the students' attention to the instructions on the board. Remind them that group reports will be given 10 minutes before the end of this lesson period.

3. Group reports

a. Call on each reporter in turn to make a report according to the directions given.

b. Encourage class discussion after all the reports have been made.

c. You or one of the students may wish to summarize similarities or differences among groups as to the forecasts made and their influence on other aspects of society.

Answers to questions on page 73 — Railroad Futures

1) *All three developments (a, b and c) might explain the increase. The answer is d.*

2) *Improved road beds and a ban on some types of aircraft (a and b) would probably result in an increase. The answer is c.*

3) *Forecast D is unlikely because of the energy crisis but also, in general, it is rare for any enterprise to die out completely.*

4-5) *(For discussion purposes).*

4. Homework

a. Students should read pages 74-80 in their Lesson Books and write responses to the questions on pages 74, 76 and 80 in their notebooks. This assignment should be completed before the next lesson.

b. Collect students' written responses to the questions posed on pages 64, 68, 70 and 73. Review these responses and provide feedback to students as you see fit.

ACCELERATING TRENDS

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Accelerating trends. Teacher-led review of the information presented and questions posed on pages 74-76.	LB-74 to 76	15-20
2. Food and People: Part I. Students discuss their answers to the questions posed on page 80.	LB-80	15-20
3. Homework. Students read pages 81-85 and complete the tasks assigned on page 85.	LB-81 to 85	5

Unit II
Lesson 12

ACCELERATING TRENDS

GOALS:

To introduce the principle of an accelerating trend;
To provide for practice in interpreting and extending accelerating trends;
To involve students in a discussion of the relationship between accelerating trends (population and food consumption) and fixed resources (food, land, water).

OBJECTIVES:

Students will be able to differentiate between a "straight line" extrapolation of a trend and an "accelerating trend."
Students will be able to define "accelerating trend" in general terms and give at least one appropriate example.
Students will be able to define and explain the function of a cross-impact matrix.
Given a matrix and the factors to be considered, students will be able to write appropriate impact statements within the matrix.

MATERIALS:

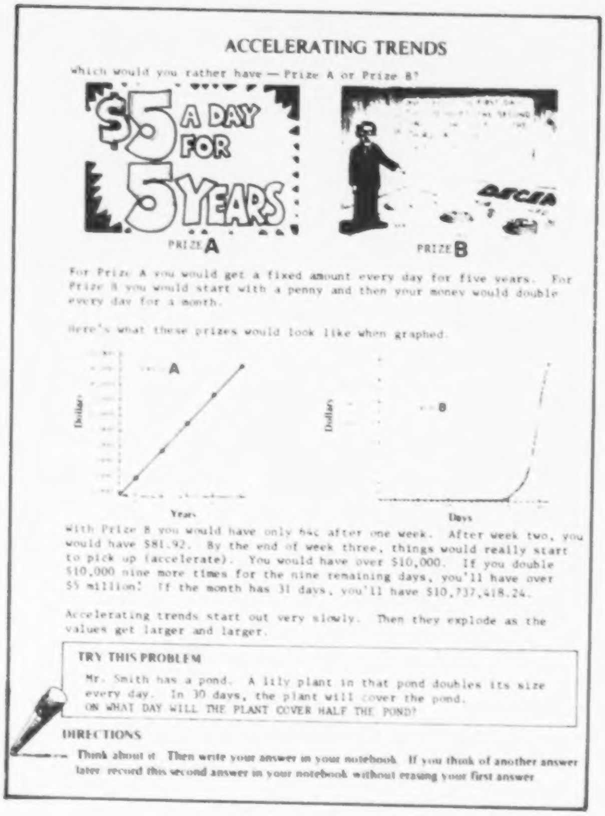
Lesson Books, notebooks.

PREPARATION:

Read pages 74-80 in the Lesson Book. Students should have completed the written assignments presented on pages 74, 76 and 80.

DIRECTIONS:

1. Accelerating trends
   a. Review responses to the questions on page 74.
      1) Ask how many students think (or thought) that Prize A is (was) the better deal. Ask for a volunteer to explain why this is an example of an accelerating trend. Point out the difference between an arithmetic rate of growth (2·4·6·8) vs. a geometric rate (2·4·8·16).


$5 A DAY FOR 5 YEARS
PRIZE A
PRIZE B
A
Dollars
Years
B
Dollars
Days

ACCELERATING TRENDS

Which would you rather have — Prize A or Prize B?

For Prize A you would get a fixed amount every day for five years. For Prize B you would start with a penny and then your money would double every day for a month.

Here's what these prizes would look like when graphed.

With Prize B you would have only 64¢ after one week. After week two, you would have $81.92. By the end of week three, things would really start to pick up (accelerate). You would have over $10,000. If you double $10,000 nine more times for the nine remaining days, you'll have over $5 million! If the month has 31 days, you'll have $10,737,418.24.

Accelerating trends start out very slowly. Then they explode as the values get larger and larger.

TRY THIS PROBLEM

Mr. Smith has a pond. A lily plant in that pond doubles its size every day. In 30 days, the plant will cover the pond.
ON WHAT DAY WILL THE PLANT COVER HALF THE POND?

DIRECTIONS

Think about it. Then write your answer in your notebook. If you think of another answer later, record this second answer in your notebook without erasing your first answer.

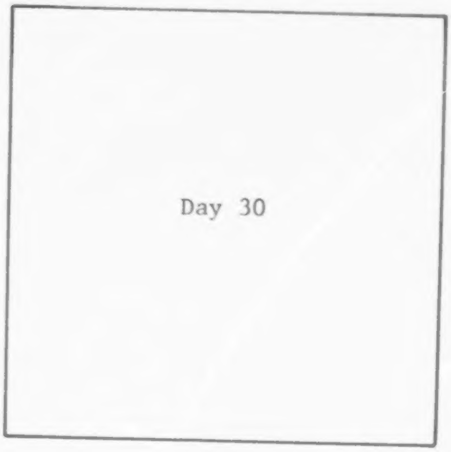
The purpose of this exercise is to illustrate that:

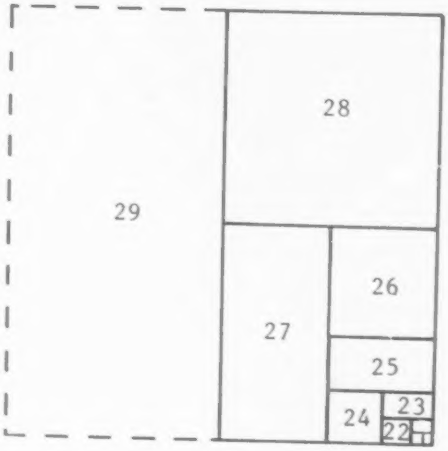
- *Most people have difficulty imagining the consequences of rapid growth.*
- *Rapid growth necessitates careful planning.*
- *The world and its resources are finite.*
- *People are using up the available space and materials very quickly.*

2) *The lily plant will cover half the pond on the 29th day.*

You may illustrate the question and answer by drawing a large square on the board. The square represents the covered pond on day 30. Half the square is the area covered on day 29. A quarter of the square is the area covered on day 28, and so on.

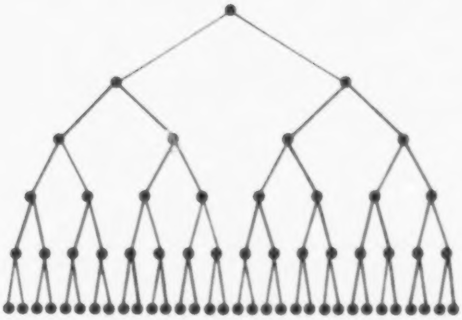
Continue dividing the remaining space.





b. *Optional.* If you think your students need further clarification of the impact of rapid growth, you may do either or both of the following:

Ask if any student has been involved in a Round Robin or chain letter. Explain the chain letter or pyramid concept through the use of a chart: One person contacts two, each of the two contacts two more, who in turn contact two, etc.



Designate a small area in the room as "the world." Populate your "world" with a family of four. Gradually add daughters or sons-in-law and grandchildren. Explain that no one leaves the world (dies) until after the great-grandchildren are born since medical science is keeping everyone healthy. The population of your world will accelerate rapidly. (With no more than two children per couple, one family can build an extended family of almost 2000 members, not including in-laws, in just ten generations.) Explain that if this activity were presented on a graph, the graph would look very similar to the one on page 76.

c. Review responses to the questions posed on page 76. (Answers are below.)

1)

YEAR	*POPULATION IN BILLIONS*
2001	*(6.8)*
2011	*(8.2)*
2021	*(10.2)*
2031	*(12.2)*
2041	*(15.0)*
2051	*(18.3)*

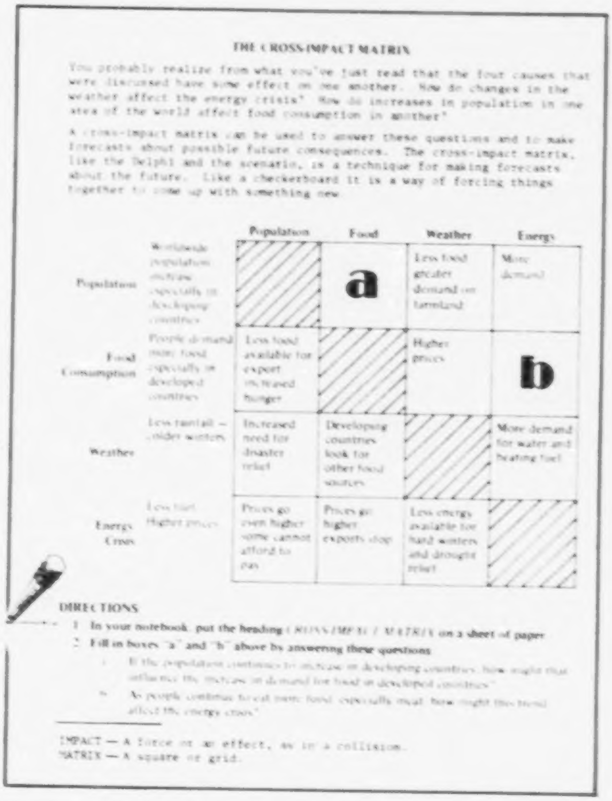
2) The 1961 population (3.1 billion) will double to 6.2 billion by 1999. Doubling time = 38 years.

3) The 1999 population (6.2 billion) will double (to 12.4 billion) by 2033. Doubling time = 34 years.

2. Food and People — Part I

You may wish to devote the remaining time in this session to a discussion of the food problem. One possibility is to have students clarify each of the aspects of the crisis discussed in the reading —population growth, food consumption, water consumption, changes in the weather and the energy crisis. Draw students' attention to the inherent conflict between an accelerating trend and fixed resources that pervades all four of those aspects. You may wish to update this information with recent trends and events. Students' responses to page 80 could be reviewed then at the beginning or middle of the next session.

a. Have students turn to page 80 in their Lesson Books. Ask students to describe a cross-impact matrix in their own words. Review the definitions of "cross-impact" and "matrix" if necessary.



THE CROSS-IMPACT MATRIX

You probably realize from what you've just read that the four causes that were discussed have some effect on one another. How do changes in the weather affect the energy crisis? How do increases in population in one area of the world affect food consumption in another?

A cross-impact matrix can be used to answer these questions and to make forecasts about possible future consequences. The cross-impact matrix, like the Delphi and the scenario, is a technique for making forecasts about the future. Like a checkerboard it is a way of forcing things together to come up with something new.

		Population	Food	Weather	Energy
Population	Worldwide population increase especially in developing countries	▨	a	Less food greater demand on farmland	More demand
Food Consumption	People demand more food especially in developed countries	Less food available for export increased hunger	▨	Higher prices	b
Weather	Less rainfall — colder winters	Increased need for disaster relief	Developing countries look for other food sources	▨	More demand for water and heating fuel
Energy Crisis	Less fuel Higher prices	Prices go even higher some cannot afford to pay	Prices go higher exports stop	Less energy available for hard winters and drought relief	▨

DIRECTIONS

1. In your notebook, put the heading *CROSS-IMPACT MATRIX* on a sheet of paper.
2. Fill in boxes "a" and "b" above by answering these questions:
   a. If the population continues to increase in developing countries, how might that influence the increase in demand for food in developed countries?
   b. As people continue to eat more food, especially meat, how might this trend affect the energy crisis?

IMPACT — A force or an effect, as in a collision.
MATRIX — A square or grid.

b. Review students' responses to the questions on page 80. Possible responses include:

1) For "a," *a continuing increase in population that is not accompanied by an increase in local food production or imports might mean more criticisms lodged against affluent countries, an increase in unrest and war within and between developing countries, and a greater need for emergency exports which might cause scarcities or higher prices in developed countries.*

2) For "b," *a continuing increase in consumption would probably result in a greater proportion of the world's energy resources being used by developed countries (fuel, fertilizer, irrigation). The result would be heightening of the energy crisis for developing countries.*

c. Inform students that they will receive additional practice with the cross-impact matrix during the next session.

3. Homework

Students should complete the "Food and People" reading (pages 81 to 85 in their Lesson Books) and answer the questions on page 85 in their notebooks.

CONSTRUCTING FORECASTS WITH A CROSS-IMPACT MATRIX

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Introduction.		
2. Varieties of cross-impact matrices. Students read pages 86-87 and generate ideas for a personal impact matrix.	LB-86 to 87	5-8
3. Filling in a cross-impact matrix. Students generate consequences and ideas for selected squares of the matrix on page H-18.	H-18	10-12
4. "Food and People" matrix *(optional)* A review of the matrix on page 80.	LB-80	10-15
{ *optional break point* }		
5. Homework review.	LB-84 to 85	10-12
6. Homework. Students complete all previous tasks and reading assignments.		3

CONSTRUCTING FORECASTS WITH A CROSS-IMPACT MATRIX

GOALS:

To introduce the principle of a cross-impact matrix;
To give students practice at using different types of matrices.

OBJECTIVES:

Given three factors and a list of developments, students will be able to construct and complete a cross-impact matrix.
Students will be able to recall and use problem definition strategies from Unit I to construct challenge statements.

MATERIALS:

Lesson Books, notebooks and H-18 (Cross-Impact Matrix).

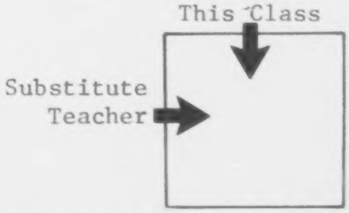
PREPARATION:

Read pages 81 to 87 in the Lesson Book and the section headed "Cross-Impact Matrix" in the Reference Section. Students should have read pages 81-85 and completed the assignment on page 85.

DIRECTIONS:

1. Introduction

   a. Draw a square on the board.

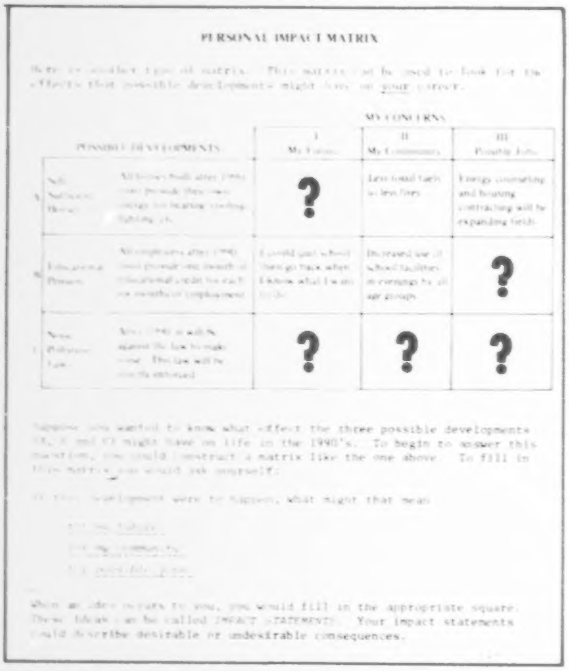


   b. Ask the class to think about what happens or what might happen when a substitute teacher is called in to teach this (or any) class.

      - How does the class change when a substitute teacher is present?
      - What impact does the class have on the substitute teacher?
      - What are some positive results?
      - What are some negative results?

   Point out that in a cross-impact matrix, it is possible to look for effects from left to right or from right to left.

2. Varieties of cross-impact matrices


PERSONAL IMPACT MATRIX

a. Have students read pages 86-87 in their Lesson Books.

b. Ask students to suggest additions to the matrix on page 87. Clarify as necessary.

c. Point out that a matrix can be used to:

- Identify positive consequences.
- Identify negative consequences.
- Look for ideas or additional developments.

d. Select an open square or two from the matrix on page 87. Ask for volunteers to give positive consequences, negative consequences and possible new developments.

3. Filling in a cross-impact matrix

a. Have students look at the matrix in their notebooks (H-18).

b. Point out that each square in this matrix can be filled with positive consequences, negative consequences or ideas. Point out also that in a cross-impact matrix you can look at the impact of a row on a column as well as a column on a row (A→I or I→A).

The question to ask with a matrix is, "What might happen to A if B came true?" or "What might the world be like if both A and B came true?"

c. Tell the students to assume that it is 25 years in the future and that all developments and factors on the matrix are true. Ask volunteers to suggest possible or probable changes, events or inventions that could be brought about by the impact of the two sets of developments. Allow a few minutes' discussion before asking the class to decide what might be written in the impact squares.

d. Begin with the Conservation Economy-Improved Work Conditions square. Ask what the impact of fuel shortages might be on shorter hours and longer vacations (e.g., less trips, second jobs). Ask what the impact of shorter hours might be on fuel shortages (more time to insulate homes, build solar reflectors).

e. Help students to fill in positive and negative impacts for some of the more difficult squares. You may suggest impact statements from your copy of the matrix if you wish.

CROSS IMPACT MATRIX

		BETTER HEALTH CARE	CONSERVATION ECONOMY	KNOWLEDGE REVOLUTION
		• more people • longer life expectancy • synthetic organs	• fuel shortages • more recycling • new energy sources	• computers • information-processing equipment • two-way TV's
IMPROVED WORK CONDITIONS	• shorter hours • longer vacations • more participation in decisions	higher unemployment more participation of the elderly population less lost time for sickness	less mobility new uses for vacation time more concern for home improvements conservation-conscious workers	more people have access to computers for decision making voting, polling by computer decreases in hours worked, more competition for jobs increase in work-at-home jobs
GROWTH IN LEISURE INDUSTRY	• recreation is big business • increased demand for parks	increased growth of leisure/demand for services and parks increased health-oriented vacations and services	waste-free recreation less traveling on vacations more park land used for mining possible reduction in leisure growth	computerized recreation activities computer selection of vacation spots and times stay-at-home vacations educational leisure
CHANGES IN STYLE AND TYPE OF WORK	• more services • more people working for themselves • more counseling and consultants	more health services more geriatric services health counseling post-retirement businesses increase in sun-belt population increased competition in service jobs	more conservation services, counseling recycling becomes an industry increased need for education	increase in "communicating to work" increase in computer consultants decrease in "stores" increased need for education

4. "Food and People" matrix *(optional)*

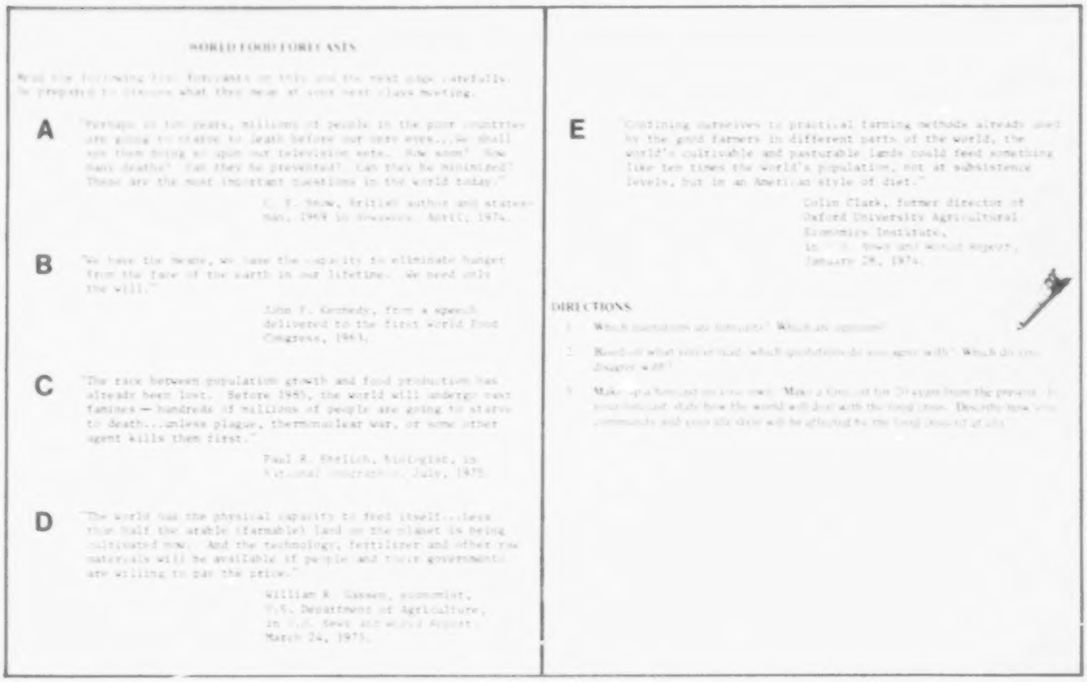
Review students' responses to the partially completed matrix on page 80 if you have not already done so or if you think that students need additional practice.

5. Homework review

   a. Review students' responses to the task outlined on page 85.

   b. Discuss the quotations with respect to expertise, recency, bias, and consistency with known (recent) facts.

   c. Have students share and defend their forecasts. Duscuss implications.



WORLD FOOD FORECASTS

Read the following five forecasts on this and the next page carefully. Be prepared to discuss what they mean at your next class meeting.

A "Perhaps in ten years, millions of people in the poor countries are going to starve to death before our very eyes...We shall see them doing so upon our television sets. How soon? How many deaths? Can they be prevented? Can they be minimized? These are the most important questions in the world today."

C. P. Snow, British author and statesman, 1969 in Newsweek, April, 1974.

B "We have the means, we have the capacity to eliminate hunger from the face of the earth in our lifetime. We need only the will."

John F. Kennedy, from a speech delivered to the first World Food Congress, 1963.

C "The race between population growth and food production has already been lost. Before 1985, the world will undergo vast famines — hundreds of millions of people are going to starve to death...unless plague, thermonuclear war, or some other agent kills them first."

Paul R. Ehrlich, biologist, in National Geographic, July, 1975.

D "The world has the physical capacity to feed itself...less than half the arable (farmable) land on the planet is being cultivated now. And the technology, fertilizer and other raw materials will be available if people and their governments are willing to pay the price."

William R. Gasser, economist, U.S. Department of Agriculture, in U.S. News and World Report, March 24, 1975.

E "Confining ourselves to practical farming methods already used by the good farmers in different parts of the world, the world's cultivable and pasturable lands could feed something like ten times the world's population, not at subsistence levels, but in an American style of diet."

Colin Clark, former director of Oxford University Agricultural Economics Institute, in U.S. News and World Report, January 28, 1974.

DIRECTIONS

1. Which quotations are forecasts? Which are opinions?
2. Based on what you've read, which quotations do you agree with? Which do you disagree with?
3. Make up a forecast on your own. Make a forecast for 20 years from the present. In your forecast, state how the world will deal with the food crisis. Describe how your community and your life style will be affected by the food crisis [illegible]

6. Homework

Have students complete all previous assignments. Tell students that they will be conducting a group problem-solving task during the next session. Students who have not yet completed the "Food and People" reading should do so before the next class meeting.

FOOD AND PEOPLE
GROUP TASK

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Changing complaints into challenges. Students complete the task assigned on page 88.	LB-88	10-12
2. Group task. Students complete the group task outlined on pages H-19 and H-20.	H-19 H-20 LB-89	20-40
optional break point		
3. Group reports.		15-25
4. Homework. Students read the introduction to Unit III and complete the tasks assigned.	LB-93 to 99 H-21	3

FOOD AND PEOPLE
GROUP TASK

GOALS:

To provide for practice in constructing and using a cross-impact matrix;
To provide for a review of skills and strategies learned in Unit I;
To provide an opportunity for groups to select a problem and to work on their own.

OBJECTIVES:

Students will be able to identify and define a problem.
Students will be able to construct a cross-impact matrix suitable for their own problem.
Students will be able to proceed through the problem-solving steps with minimal guidance.

MATERIALS:

Lesson Books, notebooks, pages H-19 and H-20 (Food and People Group Task).

PREPARATION:

Review the directions for the task outlined on pages H-19 and H-20.

DIRECTIONS:

The purpose of this lesson is to provide an opportunity for students to get involved in the future by having them select an aspect of the food crisis, define a problem within that area, and then generate possible solutions for the problem. The cross-impact matrix technique can be used to help students identify a problem and to look at the consequences of solution ideas, (e.g., the impact of a trend such as the fuel crisis on the acceptance or workability of that idea).

As has been noted in the Lesson Book, the "food crisis" is not a recognized crisis in the United States. In order for students to get the most out of this session, it is recommended that the groups choose some aspect of the global food problem that is "close to home." This may require some research or you may wish to encourage students to brainstorm how the food crisis is most likely to affect their daily lives in the future.

1. Changing complaints into challenges

   a. Have students read the directions on page 88.

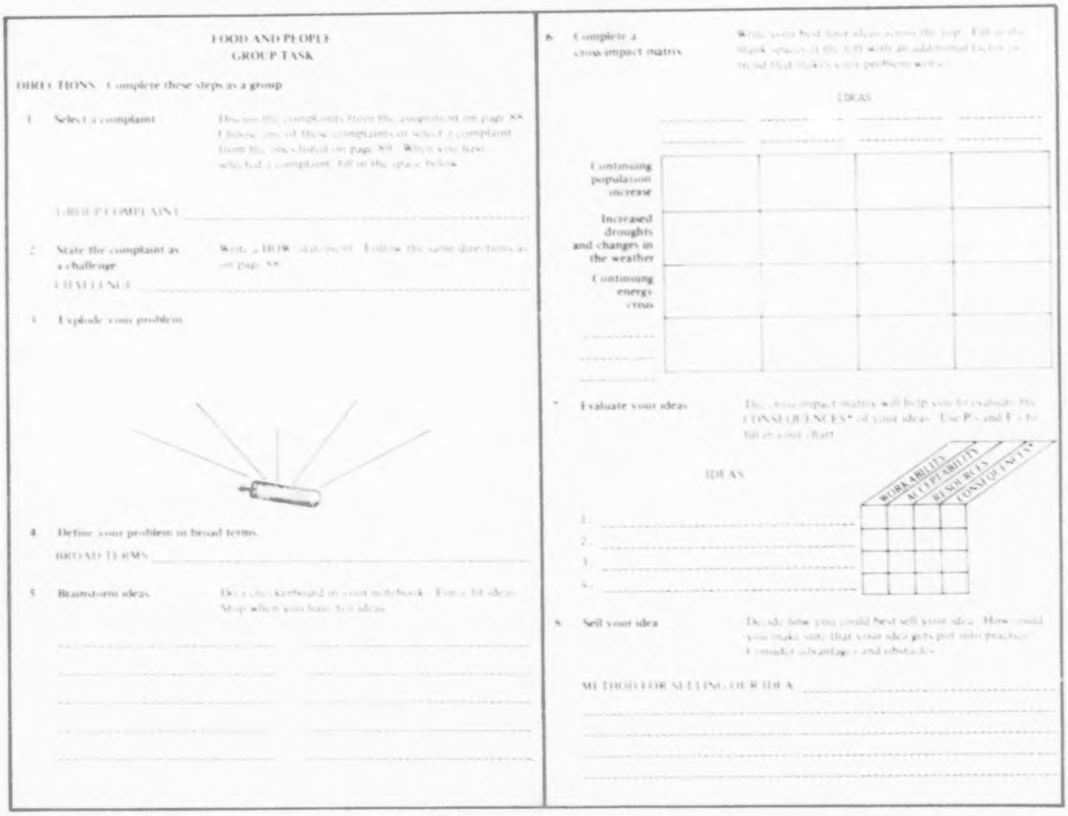
   b. Give the class ten minutes to choose complaints and to write challenge statements. Encourage students to take their time and select complaints that interest them.

   c. Give the class an additional five minutes to brainstorm ideas for the challenges they selected. Remind them of the strategies they learned in Unit I.

2. Group task

   a. Have students work in groups following the directions outlined on pages H-19 and H-20. Clarify the directions as necessary. Point out that the complaints listed on page 89 are merely suggestions. Each group should choose a problem that is of interest to all group members.

   b. Allow the remainder of the period for group work. Leave ten minutes at the end of the session for brief group reports.



FOOD AND PEOPLE
GROUP TASK

DIRECTIONS: Complete these steps as a group.

1. **Select a complaint** — Discuss the complaints from the assignment on page 88. Choose one of these complaints or select a complaint from the ones listed on page 89. When you have selected a complaint, fill in the space below.

GROUP COMPLAINT ______________________

2. **State the complaint as a challenge** — Write a HOW statement. Follow the same directions as on page 88.

CHALLENGE ______________________

3. **Explode your problem**

4. **Define your problem in broad terms.**

BROAD TERMS ______________________

5. **Brainstorm ideas** — Do a checkerboard in your notebook. Force fit ideas. Stop when you have ten ideas.

6. **Complete a cross-impact matrix** — Write your best four ideas across the top. Fill in the blank spaces at the left with an additional factor or trend that makes your problem worse.

	IDEAS			
Continuing population increase				
Increased droughts and changes in the weather				
Continuing energy crisis				

7. **Evaluate your ideas** — The cross-impact matrix will help you to evaluate the CONSEQUENCES* of your ideas. Use P's and F's to fill in your chart.

IDEAS	WORKABILITY	ACCEPTABILITY	RESOURCES	CONSEQUENCES*
1.				
2.				
3.				
4.				

8. **Sell your idea** — Decide how you could best sell your idea. How could you make sure that your idea gets put into practice? Consider advantages and obstacles.

METHOD FOR SELLING OUR IDEA ______________________

3. Group reports

   a. List some "points to cover" on the board for the group reports. For example:

      1) Our complaint
      2) Our challenge
      3) Our best ideas
      4) Major obstacles (from the cross-impact matrix)
      5) How we could get around these obstacles
      6) How we could sell our idea

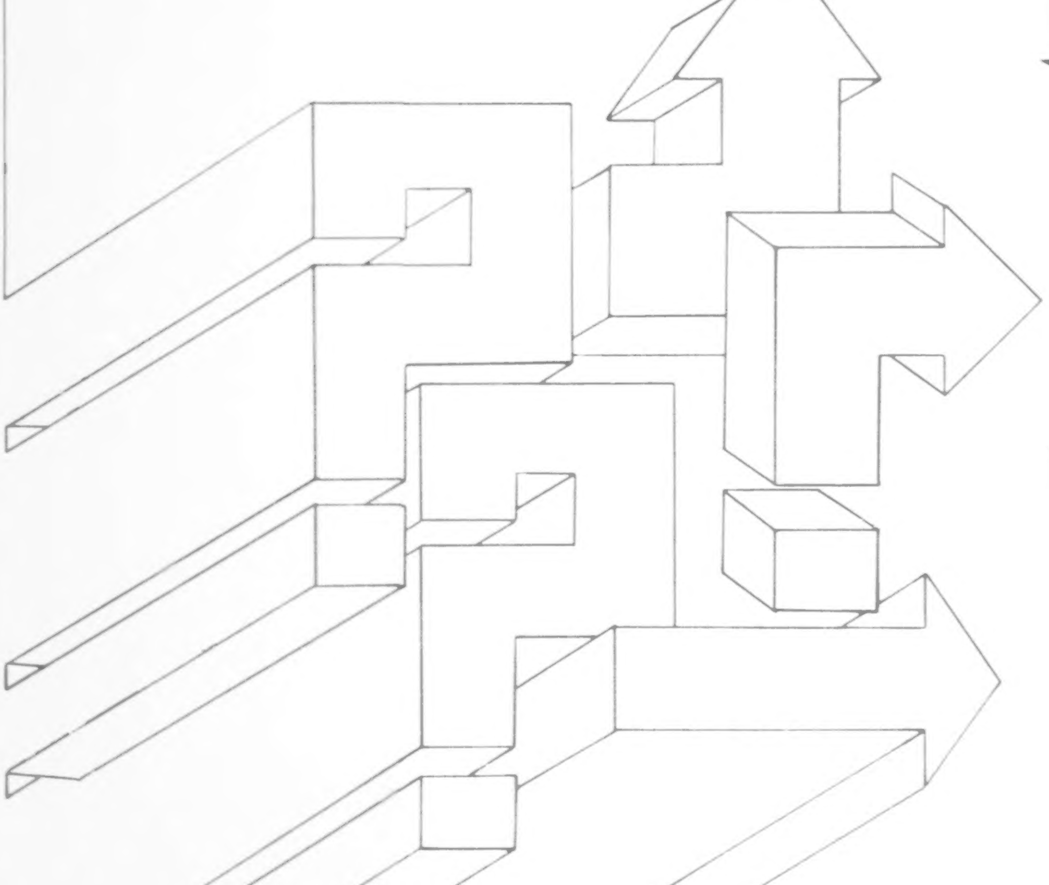
   b. Give each group two minutes or more for a brief report.

4. Homework

   Have students read the introduction to Unit III on pages 93 to 99 in the Lesson Book and complete the tasks assigned on pages 96, 97, 99 and H-21.

MAKING CHANGES

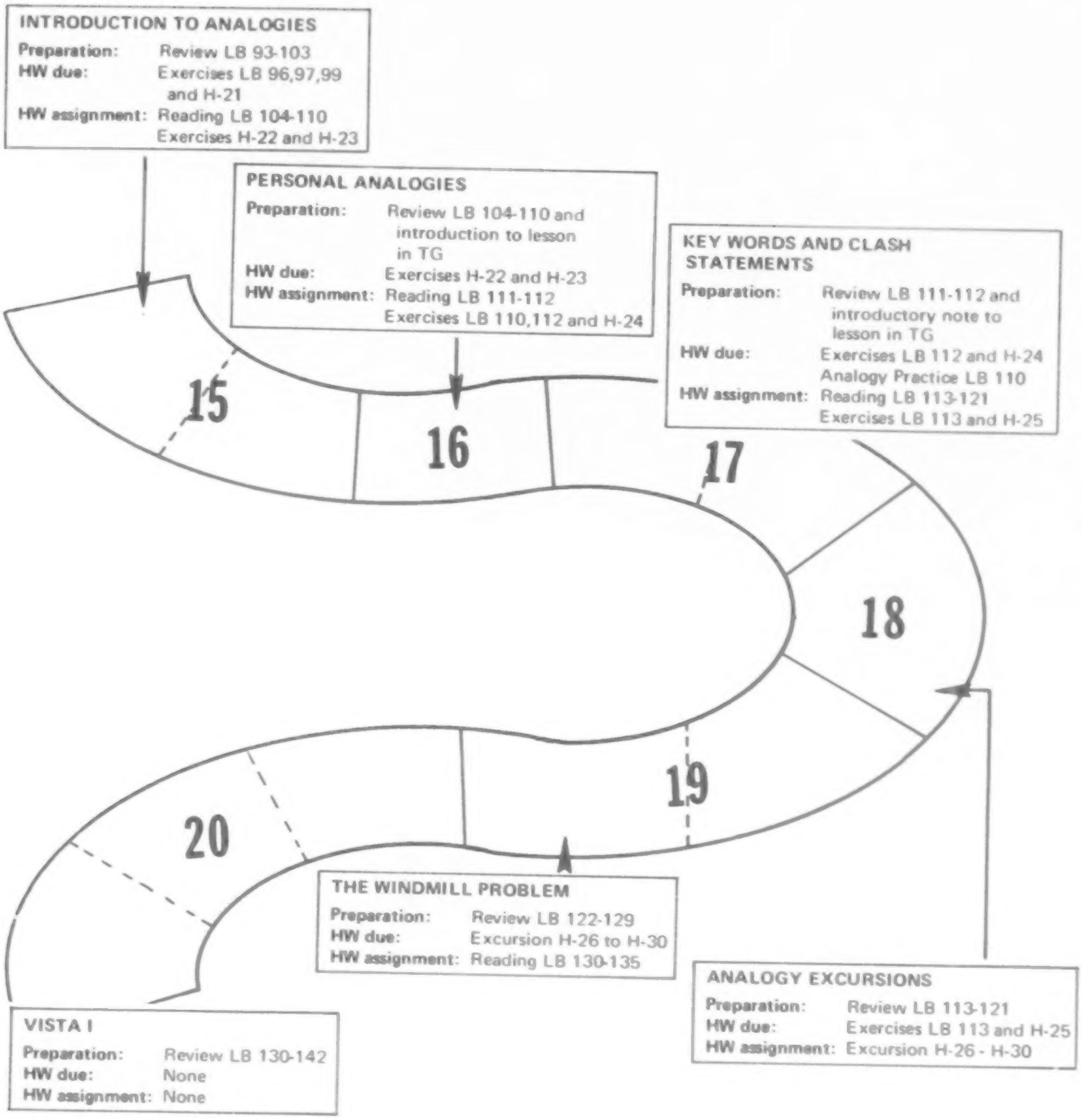
a futures-oriented course in inventive problem solving



Unit
III

CALENDAR AND HOMEWORK SUMMARY

UNIT III



INTRODUCTION TO ANALOGIES

Preparation: Review LB 93-103
HW due: Exercises LB 96,97,99 and H-21
HW assignment: Reading LB 104-110
Exercises H-22 and H-23

PERSONAL ANALOGIES

Preparation: Review LB 104-110 and introduction to lesson in TG
HW due: Exercises H-22 and H-23
HW assignment: Reading LB 111-112
Exercises LB 110,112 and H-24

KEY WORDS AND CLASH STATEMENTS

Preparation: Review LB 111-112 and introductory note to lesson in TG
HW due: Exercises LB 112 and H-24
Analogy Practice LB 110
HW assignment: Reading LB 113-121
Exercises LB 113 and H-25

ANALOGY EXCURSIONS

Preparation: Review LB 113-121
HW due: Exercises LB 113 and H-25
HW assignment: Excursion H-26 - H-30

THE WINDMILL PROBLEM

Preparation: Review LB 122-129
HW due: Excursion H-26 to H-30
HW assignment: Reading LB 130-135

VISTA I

Preparation: Review LB 130-142
HW due: None
HW assignment: None

INTRODUCTION TO ANALOGIES

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Introduction. Teacher-led review of students' responses to the homework assignment.	LB-96, 99 H-21	10-20
2. Wish statements. Students are asked to read and respond to the questions posed on 101-103 in the Lesson Book.	LB-101 to 103	10-20
optional break point		
3. Group work. Groups choose a problem from page 103 and generate wish statements and analogy ideas.	LB-103	10-15
4. Homework. Students are to read pages 104-110 and complete the problems on pages H-22 and H-23.	LB-104 to 110 H-22 H-23	3

INTRODUCTION TO ANALOGIES

GOALS:

To teach students to search for analogies by posing questions;
To introduce the "wish statements" technique associated with analogy excursions.

OBJECTIVES:

Students should be able to define "analogy" and give examples of analogies.
Students should be able to define and use "wish statements."
Students should know and be able to use the three questions that facilitate the discovery of analogies: "What would I wish for...?" "Who else has a problem like this one?" and "What does this problem suggest?"

MATERIALS:

Lesson Books, notebooks, and H-21 (Thinking of Analogy Ideas).

PREPARATION:

Read pages 93-103 in the Lesson Book. Students should have read pages 93-99 and completed the assignments on pages 96, 97 and 99, as well as on page H-21.

DIRECTIONS:

1. Introduction

   a. Have students turn to the descriptions of famous inventions they wrote for homework (assigned on page 96).

   b. Begin by asking for volunteers to read their descriptions of how they invented the fish net. Briefly do the same for the remaining five inventions: The first apartment house, the first party toy, wall-to-wall carpeting, wall shelves, and barbed wire.

c. Ask for volunteers to describe a possible solution for the problem on page 99. Probe students in order to find out how they arrived at the solution. Reinforce the usefulness of the questions introduced on page 99.

d. Write the following on the board:

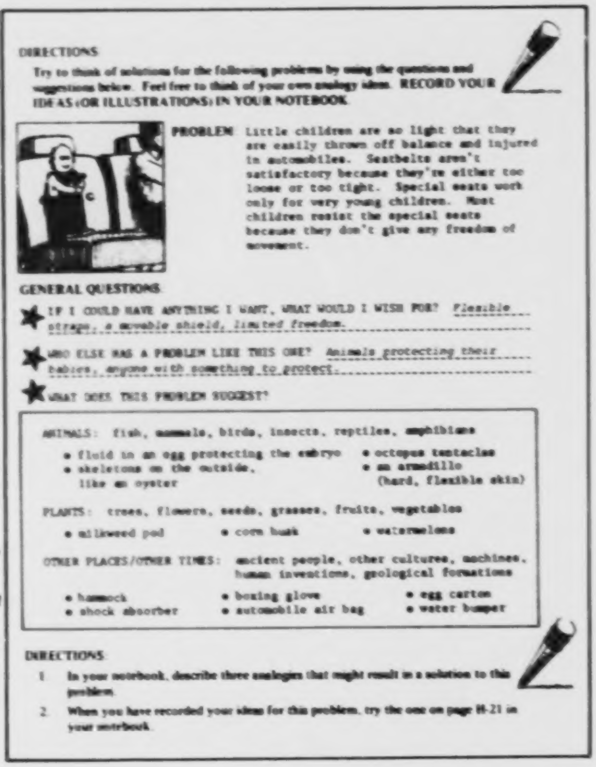
Looking for Analogies

1) If I could have anything I want, what would I wish for?

2) Who else has or had a problem like this one?

3) What does this problem suggest?

- *Animals*
- *Plants*
- *Other places/ other times*



DIRECTIONS

Try to think of solutions for the following problems by using the questions and suggestions below. Feel free to think of your own analogy ideas. **RECORD YOUR IDEAS (OR ILLUSTRATIONS) IN YOUR NOTEBOOK.**

PROBLEM Little children are so light that they are easily thrown off balance and injured in automobiles. Seatbelts aren't satisfactory because they're either too loose or too tight. Special seats work only for very young children. Most children resist the special seats because they don't give any freedom of movement.

GENERAL QUESTIONS

★ IF I COULD HAVE ANYTHING I WANT, WHAT WOULD I WISH FOR? *Flexible straps, a movable shield, limited freedom.*

★ WHO ELSE HAS A PROBLEM LIKE THIS ONE? *Animals protecting their babies, anyone with something to protect.*

★ WHAT DOES THIS PROBLEM SUGGEST?

ANIMALS: fish, mammals, birds, insects, reptiles, amphibians

- fluid in an egg protecting the embryo
- skeletons on the outside, like an oyster
- octopus tentacles
- an armadillo (hard, flexible skin)

PLANTS: trees, flowers, seeds, grasses, fruits, vegetables

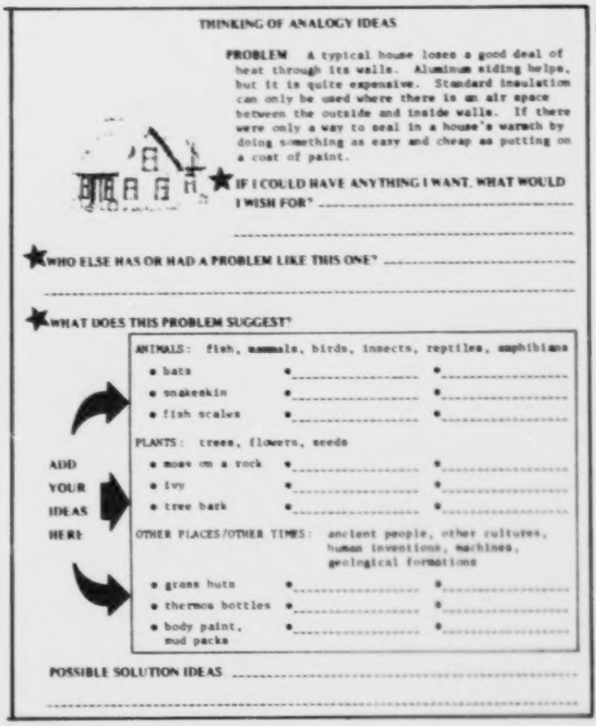
- milkweed pod
- corn husk
- watermelons

OTHER PLACES/OTHER TIMES: ancient people, other cultures, machines, human inventions, geological formations

- hammock
- shock absorber
- boxing glove
- automobile air bag
- egg carton
- water bumper

DIRECTIONS

1. In your notebook, describe three analogies that might result in a solution to this problem.
2. When you have recorded your ideas for this problem, try the one on page H-21 in your notebook.



THINKING OF ANALOGY IDEAS

PROBLEM A typical house loses a good deal of heat through its walls. Aluminum siding helps, but it is quite expensive. Standard insulation can only be used where there is an air space between the outside and inside walls. If there were only a way to seal in a house's warmth by doing something as easy and cheap as putting on a coat of paint.

★ IF I COULD HAVE ANYTHING I WANT, WHAT WOULD I WISH FOR? ________________

★ WHO ELSE HAS OR HAD A PROBLEM LIKE THIS ONE? ________________

★ WHAT DOES THIS PROBLEM SUGGEST?

ADD YOUR IDEAS HERE

ANIMALS: fish, mammals, birds, insects, reptiles, amphibians

- bats • ________ • ________
- snakeskin • ________ • ________
- fish scales • ________ • ________

PLANTS: trees, flowers, seeds

- moss on a rock • ________ • ________
- ivy • ________ • ________
- tree bark • ________ • ________

OTHER PLACES/OTHER TIMES: ancient people, other cultures, human inventions, machines, geological formations

- grass huts • ________ • ________
- thermos bottles • ________ • ________
- body paint, mud packs • ________ • ________

POSSIBLE SOLUTION IDEAS ________________

e. For the problem on page H-21, ask for examples of responses to all three questions on the board as well as possible solutions. Encourage students to think about how they thought of a solution.

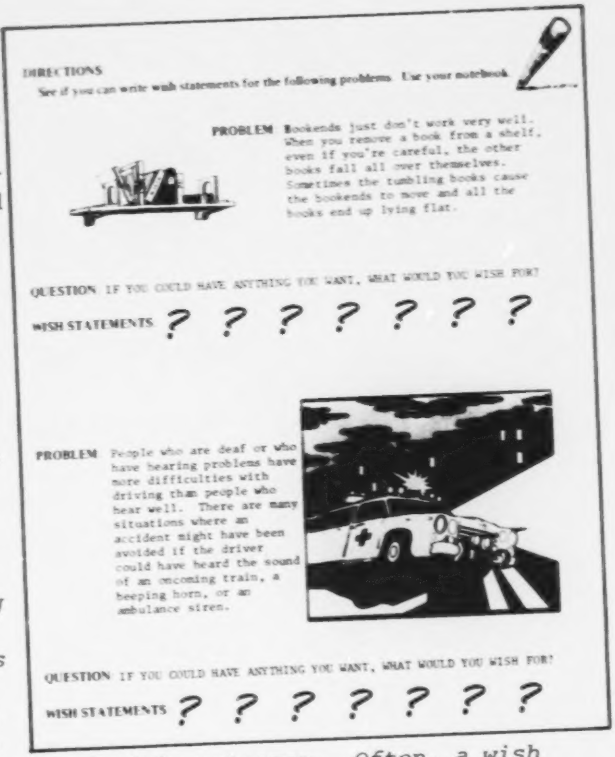
2. Wish statements

   a. Write *wish statements* on the board. Point out to students that they have already done wish statements when they answered the first question on page H-21 (and 99).

   b. Have students read page 100 and follow the directions on page 101. Help them with the two questions on page 101.

      A wish statement is the first major step in an analogy excursion. It is something like a problem statement in that you are expressing your understanding of the problem. But it is also something of a fantasy statement — an expression of the perfect goal, the best of all possible outcomes. Often, a wish statement ascribes human capabilities and volitions to inanimate objects. For example:

      - *I wish that bookends could adapt to changing conditions.*
      - *I wish that bookends could move themselves.*
      - *I wish that sounds could be seen.*
      - *I wish that other drivers would know a deaf driver when they see one.*



DIRECTIONS
See if you can write wish statements for the following problems. Use your notebook.

PROBLEM Bookends just don't work very well. When you remove a book from a shelf, even if you're careful, the other books fall all over themselves. Sometimes the tumbling books cause the bookends to move and all the books end up lying flat.

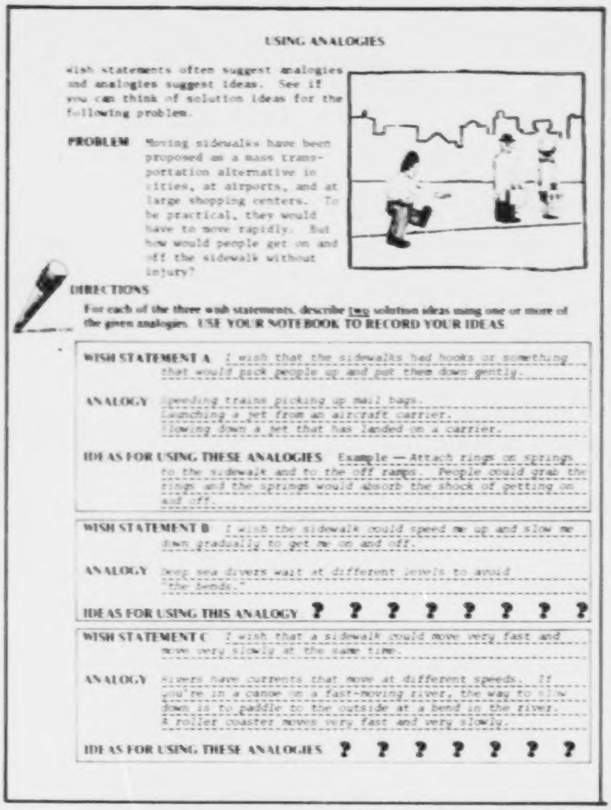
QUESTION IF YOU COULD HAVE ANYTHING YOU WANT, WHAT WOULD YOU WISH FOR?

WISH STATEMENTS ? ? ? ? ? ? ?

PROBLEM People who are deaf or who have hearing problems have more difficulties with driving than people who hear well. There are many situations where an accident might have been avoided if the driver could have heard the sound of an oncoming train, a beeping horn, or an ambulance siren.

QUESTION IF YOU COULD HAVE ANYTHING YOU WANT, WHAT WOULD YOU WISH FOR?

WISH STATEMENTS ? ? ? ? ? ? ?



USING ANALOGIES

Wish statements often suggest analogies and analogies suggest ideas. See if you can think of solution ideas for the following problem.

PROBLEM Moving sidewalks have been proposed as a mass transportation alternative in cities, at airports, and at large shopping centers. To be practical, they would have to move rapidly. But how would people get on and off the sidewalk without injury?

DIRECTIONS

For each of the three wish statements, describe two solution ideas using one or more of the given analogies. USE YOUR NOTEBOOK TO RECORD YOUR IDEAS

WISH STATEMENT A I wish that the sidewalks had hooks or something that would pick people up and put them down gently.

ANALOGY Speeding trains picking up mail bags.
Launching a jet from an aircraft carrier.
Slowing down a jet that has landed on a carrier.

IDEAS FOR USING THESE ANALOGIES Example — Attach rings on springs to the sidewalk and to the off ramps. People could grab the rings and the springs would absorb the shock of getting on and off.

WISH STATEMENT B I wish the sidewalk could speed me up and slow me down gradually to get me on and off.

ANALOGY Deep sea divers wait at different levels to avoid "the bends."

IDEAS FOR USING THIS ANALOGY ? ? ? ? ? ? ? ?

WISH STATEMENT C I wish that a sidewalk could move very fast and move very slowly at the same time.

ANALOGY Rivers have currents that move at different speeds. If you're in a canoe on a fast-moving river, the way to slow down is to paddle to the outside at a bend in the river. A roller coaster moves very fast and very slowly.

IDEAS FOR USING THESE ANALOGIES ? ? ? ? ? ? ?

c. Have students read and respond to the problem on page 102.

d. Ask students if they can think of additional wish statements and analogy ideas for the moving sidewalks problem.

e. Ask for solution ideas for the three wish statements given on page 102. Ask students to describe how the given analogies helped them think of their ideas.

There are probably a number of solution possibilities for this problem. One attack might be to devise some means of providing for acceleration and deceleration. Another solution possibility might be to have several bands, each running at a different speed. Another solution idea that has been proposed involves flexible links. The units of the sidewalk would expand on the outside of turns which would effectively reduce the speed of the sidewalk at that point.

3. Group work (*optional*)

Have students devote the remaining time to generating wish statements, analogies and solution ideas to one of the four problems on page 103. Encourage multiple wish statements. Have the group recorder record all ideas. Have the groups give reports at the end of the session if there is sufficient time.

4. Homework

a. Students should read pages 104-110 and complete the problems assigned on pages H-22 and H-23.

b. Collect the homework tasks completed for this session (responses for pages 96, 97, 99 and H-21) and provide feedback or extra help as necessary.

PERSONAL ANALOGIES

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Explosions. Teacher-led review of the two explosion examples assigned for homework.	H-22 H-23	10-20
2. Introduction to personal analogies. Students explode the "umbrella problem" on page 110.	LB-110	5-10
3. Improvising a personal analogy. Six students act out a personal analogy to the "bookends problem" on page 101.	LB-101	15-20
4. Three types of personal analogies. Students re-read about the types of personal analogies on page 109 and begin practicing for demonstrations to be given at the next session.	LB-109	10-12
5. Homework. Students should read pages 111-112 and complete the exercises on page 112 and H-24.	LB-111, 112 H-24	5

PERSONAL ANALOGIES

GOALS:

To review students' responses to the "explosion" exercises assigned as homework;
To teach guidelines for generating personal analogies;
To provide for practice in acting out personal analogies.

OBJECTIVES:

Students should be able to use the explosion technique to look for different parts (aspects) of a problem, generate wish statements for each aspect, look for analogies to match each wish statement, and generate an idea (application) for each analogy.
Students will be able to discriminate among the three types of personal analogies.

MATERIALS:

Lesson Books, notebooks, H-22 (Explosion I) and H-23 (Explosion II).

PREPARATION:

Read the introduction preceding the directions below. Read pages 104 to 110 in the Lesson Book.
Students should have read pages 104-110 and completed the tasks assigned on pages H-22 and H-23.

DIRECTIONS:

INTRODUCTION

Up to this point, students probably understand analogies as "find something similar and force fit it to the problem." This strategy tends to work best when students are very familiar with a problem. Problems that are unfamiliar or strange to students will probably not suggest analogies to them. The method introduced in this session is a way of "making the strange familiar."

A personal analogy is a way of understanding a problem by trying to experience what it feels like to be either the total problem or the parts of the problem. By acting out what it feels like to be the problem or its parts, students may:

- *understand the problem better — the "real" problem*
- *understand the interrelationships of the parts of the problem*
- *produce an analogy idea that otherwise would not have occurred to them, i.e., "This reminds me of..." or "This feels like..."*
- *become aware of and possibly generate an idea for what is needed to solve the problem.*

By the end of Section 2 of this lesson, students should be able to follow the guidelines that appear on page 110 of the Lesson Book to act out any of the three kinds of personal analogies: "Be the thing," "be the analogy," and "be the problem." Students may have difficulty with the latter two types of personal analogies, especially "be the problem." It is not recommended that mastery of all three types be required of all students. The three types of personal analogies are introduced in order to allow for individual differences in thinking styles among students and to provide as many options as possible.

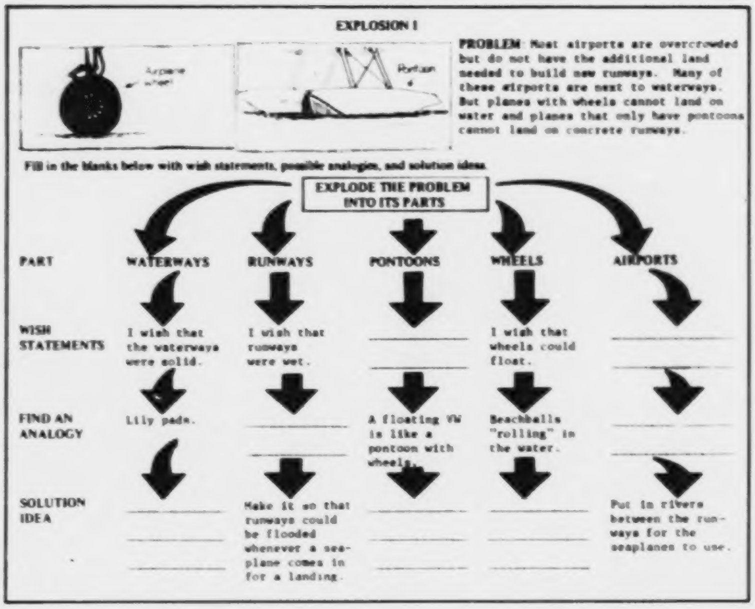
2. Explosions

   a. Ask students to recall how "explosion" was used in earlier lessons.

   b. Ask for a definition of "explosion."

   Explosion is breaking a problem into its parts. Each part or aspect represents something that might be changed.

   c. Briefly review students' responses to the problem on page H-22 assigned as homework. Students should have filled in some but not necessarily all of the blanks.

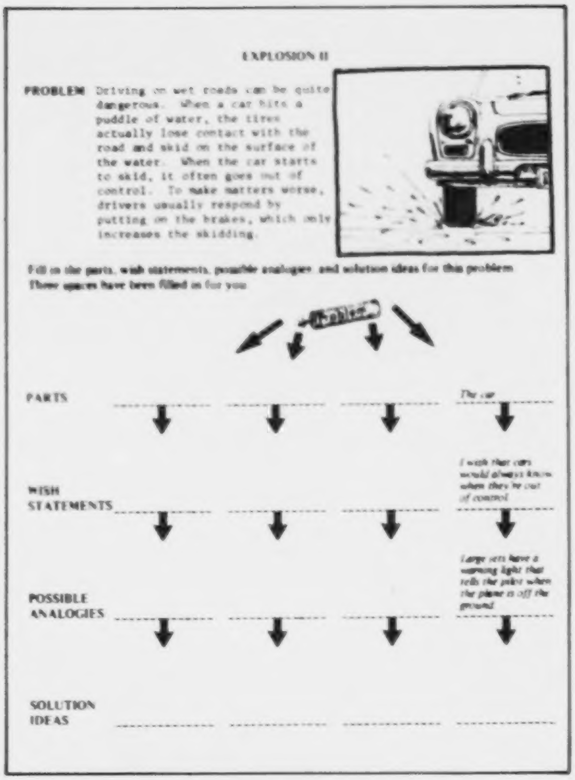

Airplane wheel
Pontoon
EXPLODE THE PROBLEM INTO ITS PARTS

EXPLOSION I

PROBLEM: Most airports are overcrowded but do not have the additional land needed to build new runways. Many of these airports are next to waterways. But planes with wheels cannot land on water and planes that only have pontoons cannot land on concrete runways.

Fill in the blanks below with wish statements, possible analogies, and solution ideas.

PART	**WATERWAYS**	**RUNWAYS**	**PONTOONS**	**WHEELS**	**AIRPORTS**
WISH STATEMENTS	I wish that the waterways were solid.	I wish that runways were wet.	______	I wish that wheels could float.	______
FIND AN ANALOGY	Lily pads.	______	A floating VW is like a pontoon with wheels.	Beachballs "rolling" in the water.	______
SOLUTION IDEA	______	Make it so that runways could be flooded whenever a seaplane comes in for a landing.	______	______	Put in rivers between the runways for the seaplanes to use.



EXPLOSION II

PROBLEM Driving on wet roads can be quite dangerous. When a car hits a puddle of water, the tires actually lose contact with the road and skid on the surface of the water. When the car starts to skid, it often goes out of control. To make matters worse, drivers usually respond by putting on the brakes, which only increases the skidding.

Fill in the parts, wish statements, possible analogies and solution ideas for this problem. These spaces have been filled in for you.

PARTS .... *The car* ....

WISH STATEMENTS .... *I wish that cars would always know when they're out of control* ....

POSSIBLE ANALOGIES .... *Large jets have a warning light that tells the pilot when the plane is off the ground* ....

SOLUTION IDEAS ....

d. Review students' responses to page H-23 from the homework assignment. Ask students to report on the parts of the problem they defined, the wish statements they wrote for these parts, the possible analogies they thought of, and the solution ideas they came up with.

The skidding problem might be divided into __four parts__: tires, water, road, and car (power source, driver, etc.)... __Possible wish statements__ include: I wish that tires couldn't float; I wish that the water would go somewhere else; I wish that roads were leaky; I wish that cars could control themselves on water. __Possible analogies__ for these wish statements include: rudders on boats; a duck's back or peaked roof; a sieve; and an automatic pilot for poor visibility in flight. __Solution possibilities__ include: rain tires that break through the surface tension on the water; oiled or peaked roads; porous roads; an anti-breaking device that would be activated when the tires leave the road surface.

2. __Introduction to personal analogies__

   a. Write the following problem statement on the board:

      How can we design a windproof umbrella?

      Ask students to explode an umbrella into its parts. Record the parts on the board. Ask for wish statements and analogy ideas for each part. (Don't be concerned if students have difficulty with generating wish statements and analogies. The exercises that follow should help them with this task.)

   b. Tell students that they will be learning a new method today that should help them in using analogies. Write the following on the board:

      Personal Analogies

3. Improvising a personal analogy

a. Have students read the bookends problem at the top of page 101.

PROBLEM: **Bookends just don't work very well. When you remove a book from a shelf, even if you're careful, the other books fall all over themselves. Sometimes the tumbling books cause the bookends to move and all the books end up lying flat.**

b. Choose six volunteers to act out a personal analogy for the bookends problem.
Note: Read the improvisation carefully before deciding which six students to choose (see section c, 1-5 below).

c. Have the six students stand in a line — four books held together by two bookends. Have the actors act out the following events and respond to the following questions:

1) "Books, how do you feel? Do you feel safe and secure? Bookends, do you feel that you are doing your job well?"

2) Ask a student from "the audience" to remove the two middle "books" from the shelf.

3) "Books, how do you feel now? Are you experiencing a problem? Can you show us what might happen now that two books have been removed?"

"Bookends, how do you feel about this problem? What do you wish for — what do you think you need in order to do a better job as bookends? Show us how you might work if you were the best of all possible bookends."

4) Ask a student from the "audience" to return the other two books to the bookshelf.

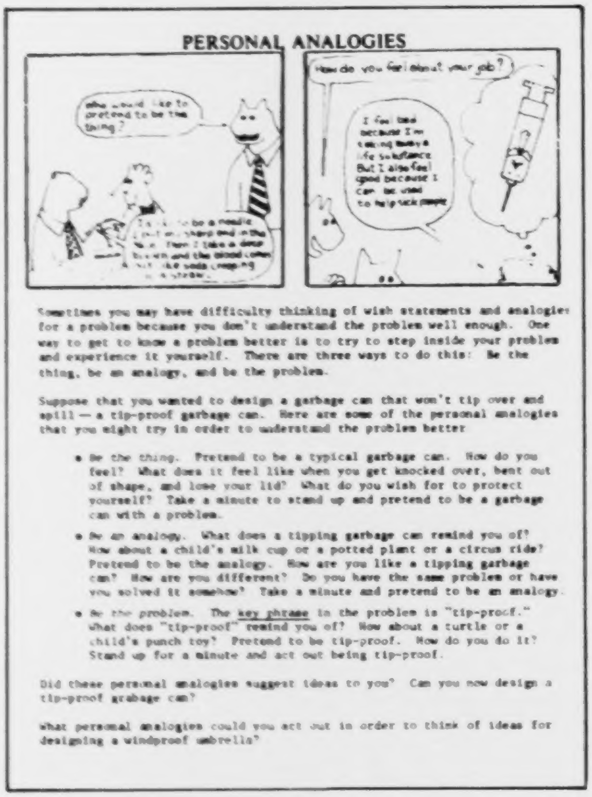
5) "Bookends, tell us what you wish for — what do you think you need in order to let these two books back in safely and securely? Show us how you might work if you were the best of all possible bookends."

e. Have the actors return to their seats. Tell the class that this was a type of personal analogy called "be the thing." Encourage a discussion. Ask the bookends if they learned anything about the "bookends problem" from their experience. Ask the bookends if the experience reminded them of anything—did it suggest an analogy?

f. Ask the class for ideas. Use any or all of the following:
   1) objects or devices that have a problem similar to the bookends' problem
   2) wish statements that the bookends might have made
   3) ideas for improving bookends
   4) description of the money-is-no-object perfect set of bookends

g. Point out that a personal analogy or "being the analogy" can help you to understand the problem. It can also remind you of other things that work in similar ways or have similar problems, which often suggests solution ideas.

4. Three types of personal analogies


Who would like to pretend to be the thing?
How do you feel about your job?
I feel bad because I'm taking away a life substance But I also feel good because I can be used to help sick people

PERSONAL ANALOGIES

Sometimes you may have difficulty thinking of wish statements and analogies for a problem because you don't understand the problem well enough. One way to get to know a problem better is to try to step inside your problem and experience it yourself. There are three ways to do this: Be the thing, be an analogy, and be the problem.

Suppose that you wanted to design a garbage can that won't tip over and spill — a tip-proof garbage can. Here are some of the personal analogies that you might try in order to understand the problem better

- Be the thing. Pretend to be a typical garbage can. How do you feel? What does it feel like when you get knocked over, bent out of shape, and lose your lid? What do you wish for to protect yourself? Take a minute to stand up and pretend to be a garbage can with a problem.
- Be an analogy. What does a tipping garbage can remind you of? How about a child's milk cup or a potted plant or a circus ride? Pretend to be the analogy. How are you like a tipping garbage can? How are you different? Do you have the same problem or have you solved it somehow? Take a minute and pretend to be an analogy.
- Be the problem. The key phrase in the problem is "tip-proof." What does "tip-proof" remind you of? How about a turtle or a child's punch toy? Pretend to be tip-proof. How do you do it? Stand up for a minute and act out being tip-proof.

Did these personal analogies suggest ideas to you? Can you now design a tip-proof grabage can?

What personal analogies could you act out in order to think of ideas for designing a windproof umbrella?

a. Have students re-read page 109.

b. Help the students to understand the nature of and differences among the three types of analogies outlined on page 109. (Use page 110 as a guide. Tell students that they will learn about "key words and phrases" in the next session.)

c. Assign two of the three types of analogies to each group (e.g., A&B, B&C, A&C, A&B, and B&C).

d. Tell the class that each group will be responsible for demonstrating two personal analogies during the next session. Each group must choose two pairs of students. One student in each pair will read one set of the questions and directions outlined on page 110 and the other student will respond to the questions and act out the analogy. Leftover students in odd-numbered groups should record responses.

e. Have students practice their demonstrations in whatever time remains. Otherwise, assign the practice as homework.

5. Homework

   a. Students should read pages 111 and 112 and do the exercises on pages 112 and H-24.

   b. Students may practice the personal analogies on page 110 for homework. Students may work individually or in pairs.

   c. Collect the homework assigned for this session (H-22 and H-23) and provide feedback as you see fit.

KEY WORDS AND CLASH STATEMENTS

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Clash statements. A review of students' responses to the questions on page 112 of the Lesson Book.	LB-112	10-12
2. Key words. Students select key words for the exercises on page H-24.	H-24	10-15
{*optional break point*}		
3. Personal analogy demonstrations. Each group demonstrates two personal analogies according to the lists on page 110 of the Lesson Book.	LB-110	15-25
4. Homework. Students read pages 113 to 121 and complete the tasks assigned on pages 113 and H-25. A leader is selected for the excursion scheduled for the next session.	LB-113 to 121 H-25	5

Unit III
Lesson 17

KEY WORDS AND CLASH STATEMENTS

GOALS:

To review the homework assignment on clash statements;
To introduce the strategy of finding the key word or phrase in a problem statement;
To practice demonstrating personal analogies.

OBJECTIVES:

Students will be able to select or generate key words for a problem as given.
Students will be able to generate clash statements.
Students will be able to act out each of the three types of personal analogies.

MATERIALS:

Lesson Book, notebooks, and H-24 (Clash Statements).

PREPARATION:

Read pages 111-112 in the Lesson Book. Read the introductory note below. Students should have read pages 111-112 and completed the assignments on pages 112 and H-24. Students were also asked to practice the personal analogies on page 110.

DIRECTIONS:

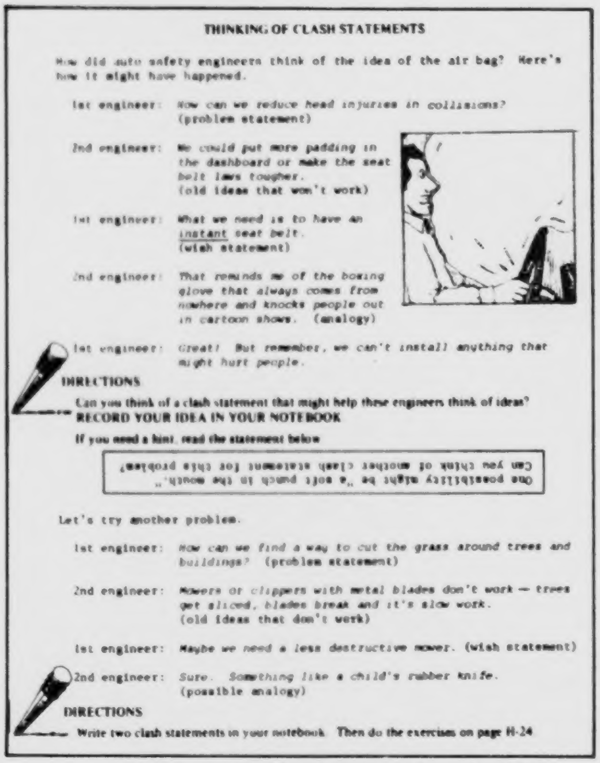
INTRODUCTION

Clash statements are a special form of wish statements. They are like wish statements in that they express what seems to be needed in order to achieve a solution to a problem. They are different from wish statements because they are usually expressed with two conflicting or opposing words, typically an adjective and a noun, and they occur midway in an analogy excursion rather than at the beginning.

Clash statements are wish statements that express frustration. They are easiest to think of when you are at a stage in an analogy excursion when you know what you want but are up against an obstacle of some sort, or when an analogy has given you a solution idea but you can't seem to force fit it to your problem. Personal analogies are a good source for clash statements since the objective of a personal analogy is to experience the tension or paradox inherent in a problem situation.

You may wish to encourage the search for clash statements throughout this lesson, especially during the student demonstrations. Encourage students to express the "good" and "bad" aspects of whatever they are pretending to be.

1. Clash statements



THINKING OF CLASH STATEMENTS

How did auto safety engineers think of the idea of the air bag? Here's how it might have happened.

1st engineer: *How can we reduce head injuries in collisions?* (problem statement)

2nd engineer: *We could put more padding in the dashboard or make the seat belt laws tougher.* (old ideas that won't work)

1st engineer: *What we need is to have an instant seat belt.* (wish statement)

2nd engineer: *That reminds me of the boxing glove that always comes from nowhere and knocks people out in cartoon shows.* (analogy)

1st engineer: *Great! But remember, we can't install anything that might hurt people.*

DIRECTIONS

Can you think of a clash statement that might help these engineers think of ideas?
RECORD YOUR IDEA IN YOUR NOTEBOOK

If you need a hint, read the statement below

One possibility might be "a soft punch in the mouth."
Can you think of another clash statement for this problem?

Let's try another problem.

1st engineer: *How can we find a way to cut the grass around trees and buildings?* (problem statement)

2nd engineer: *Mowers or clippers with metal blades don't work — trees get sliced, blades break and it's slow work.* (old ideas that don't work)

1st engineer: *Maybe we need a less destructive mower.* (wish statement)

2nd engineer: *Sure. Something like a child's rubber knife.* (possible analogy)

DIRECTIONS

Write two clash statements in your notebook. Then do the exercises on page H-24

a. Ask for a definition of a clash statement.

b. Review students' responses to the problems given on page 112 in the Lesson Book.

   1) *"Soft collision," "gentle shove," and "cushioned smash" are among the possible clash statements for the air bag problem.*

   2) Feedback for the "mower problem" is given to students at the top of H-24.

   "Flexible slicer," "gentle blade," "careful destroyer," and "safe cutter" are among the clash statements possible for this problem.

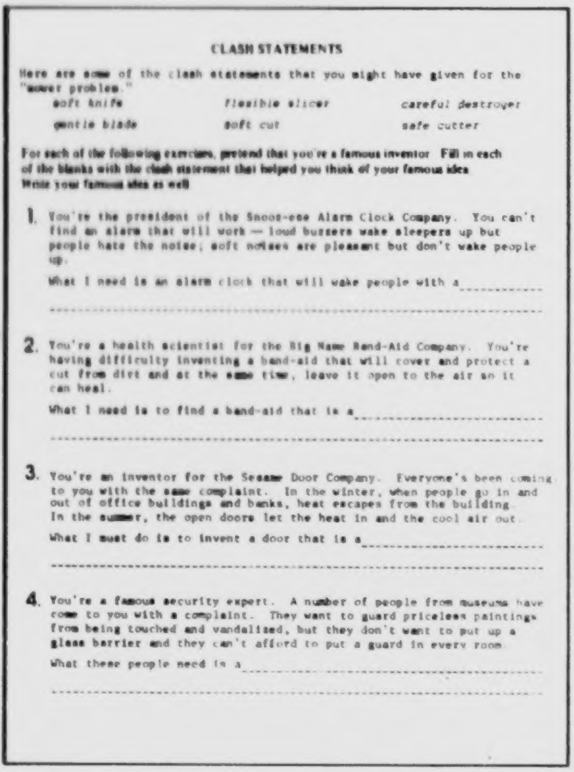
c. Ask for solution ideas for the mower problem.

Note: Students may be familiar with the lawn trimmer that cuts with a fishing line. You may wish to get students to name analogies that might have helped the inventor of this trimmer to develop the idea, e.g., "cutting candles with a whip," "cheese with a string," "fingers with paper."

2. Key words

"Key words" are combinations of words and phrases from the problem that express the problem as given in as few words as possible. It is not always possible to find the key words you need in a problem statement. Sometimes they must be made up. For example, the key word "windproof" was given for the umbrella problem, but the key words "foolproof restraint" were not *given for the airbag problem.*

The easiest way to think of clash statements is to turn the problem as given into two to three words. Clash statements, then, are extensions of those key words. Key words are definitions; clash statements are ideas spurred by these definitions.



CLASH STATEMENTS

Here are some of the clash statements that you might have given for the "mower problem."

soft knife
gentle blade
flexible slicer
soft cut
careful destroyer
safe cutter

For each of the following exercises, pretend that you're a famous inventor. Fill in each of the blanks with the clash statement that helped you think of your famous idea. Write your famous idea as well.

1. You're the president of the Snooz-ene Alarm Clock Company. You can't find an alarm that will work — loud buzzers wake sleepers up but people hate the noise; soft noises are pleasant but don't wake people up.

   What I need is an alarm clock that will wake people with a ____________

   ____

2. You're a health scientist for the Big Name Band-Aid Company. You're having difficulty inventing a band-aid that will cover and protect a cut from dirt and at the same time, leave it open to the air so it can heal.

   What I need is to find a band-aid that is a ____________

   ____

3. You're an inventor for the Sesame Door Company. Everyone's been coming to you with the same complaint. In the winter, when people go in and out of office buildings and banks, heat escapes from the building. In the summer, the open doors let the heat in and the cool air out.

   What I must do is to invent a door that is a ____________

   ____

4. You're a famous security expert. A number of people from museums have come to you with a complaint. They want to guard priceless paintings from being touched and vandalized, but they don't want to put up a glass barrier and they can't afford to put a guard in every room.

   What these people need is a ____________

   ____

a. Have students turn to page H-24.

b. Have students identify the key words in each paragraph by asking them to define each problem in two or three words.

c. Ask for clash statements for each paragraph.

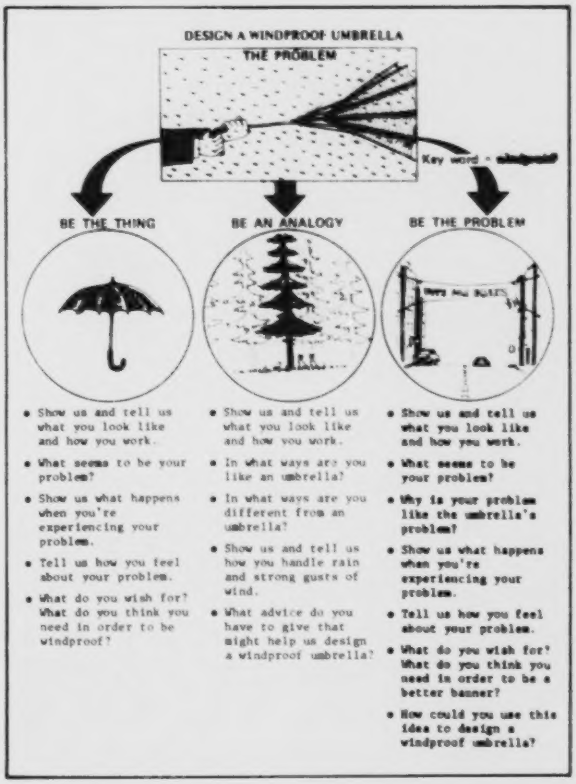
   1) Key words:
      pleasant alarm (clock)
      Possible clash statements:
      soft jolt, soothing siren, startling whisper, pleasant blast, restful earthquake.

   2) Key words:
      dirt-proof band-aid
      Possible clash statements:
      open cover, closed sieve, open barrier, leaky shield.

   3) Key words:
      escape-proof door
      Possible clash statements:
      closed opening, blocked entrance, door that's not a door.

   4) Key words:
      barrierless guard
      Possible clash statements:
      invisible wall, instant guard, ever-present guard.

3. Personal analogy demonstrations



- Show us and tell us what you look like and how you work.
- What seems to be your problem?
- Show us what happens when you're experiencing your problem.
- Tell us how you feel about your problem.
- What do you wish for? What do you think you need in order to be windproof?

- Show us and tell us what you look like and how you work.
- In what ways are you like an umbrella?
- In what ways are you different from an umbrella?
- Show us and tell us how you handle rain and strong gusts of wind.
- What advice do you have to give that might help us design a windproof umbrella?

- **Show us and tell us what you look like and how you work.**
- **What seems to be your problem?**
- **Why is your problem like the umbrella's problem?**
- **Show us what happens when you're experiencing your problem.**
- **Tell us how you feel about your problem.**
- **What do you wish for? What do you think you need in order to be a better banner?**
- **How could you use this idea to design a windproof umbrella?**

a. Have each group conduct one personal analogy demonstration for the windproof umbrella problem on page 110. Begin with "be the thing." Have one student read the directions and questions aloud while his or her partner acts out the analogy and responds to the questions. *Your probes during these demonstrations can lead students to improve their ideas and discover new ones.*
Continue until all groups have presented one analogy demonstration.

b. Whenever it seems appropriate, stop a demonstration to ask for a clash statement. Ask the demonstrator what he or she feels good and bad about. Ask the rest of the class for possible clash statements.

c. Have the group members give their second demonstration with new partners. This time, encourage students to improvise on the lists and on acting out the analogies. Have the demonstrators tell what makes them feel good and what makes them feel bad.

d. Encourage a discussion. Ask students if they found personal analogies to be helpful in understanding a problem and for looking for solution ideas. Ask students to explain how and why they found personal analogies to be helpful. Do the same for clash statements.

e. *Optional:* Discuss possible designs for a windproof umbrella.

Pretending to be an umbrella that has been yanked by the wind may have spurred the idea to install some kind of safety chain connecting the shaft to the ribs.
Pretending to be an evergreen tree may have spurred the idea to have multiple incomplete layers of fabric.
Pretending to be a banner may have spurred the idea to cut holes or slits in the fabric. Slits or holes with valves on the top side of the fabric would allow wind to pass through from the underside while preventing the rain from leaking through from above.

4. Homework

   a. Read pages 113 to 121 and complete the tasks assigned on page 113.

   b. Complete page H-25.

   c. Before the class is dismissed, choose one student to play the part of the leader in the analogy excursion activity to be acted out during the next session. This student, who will be playing the role of Lee, should be a confident student who has the respect of the rest of the class. Ask "Lee" to read the script carefully for homework.

ANALOGY EXCURSIONS

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Dramatization. Five students act out the script on pages 115 to 121 of the Lesson Book.	LB-115 to 121	15-25
2. Stages of an excursion. Teacher-led review using the illustration on page 114.	LB-114	10-12
3. Inventions. A review of the homework assignments.	LB-113 H-25	10-15
4. Homework. Students complete the excursion assigned in the handout section.	H-26 to H-30	3

ANALOGY EXCURSIONS

GOALS:

To review all the stages and techniques associated with an analogy excursion;
To teach the role of a leader in an analogy excursion.

OBJECTIVES:

Students will know and be able to use each of the stages of the excursion process.

MATERIALS:

Lesson Books, notebooks and H-25 (How I Did It).

PREPARATION:

Read pages 113 to 121. Students should have read pages 113 to 121 and completed the invention descriptions assigned on pages 113 and H-25.

DIRECTIONS:

1. Dramatization

   a. Select five good readers ("Lee" plus four participants) to read the script that begins on page 115 of the Lesson Book. Remind "Lee" that at several points in the script he/she is to ask the class for ideas. Suggest that he/she may "ad lib" in order to get the class to contribute.

   You will be playing the role of Sandy. In this role, read your lines in the first two scenes, then note ideas submitted by the class on the board. You may wish to summarize the results of the excursion at the end.

   Encourage Lee to be the leader. If you have to interrupt, try to interrupt in character and address your suggestions to Lee.

   b. Encourage the class to join in at each stage of the process.

2. Stages of an excursion

   a. Ask the class to recall the steps of the excursion process from memory. Write the names of the steps on the board.

b. Have the class turn to page 114 in the Lesson Book. Review each step and method illustrated at the bottom of the page. Ask students to define the leader's role for themselves. Emphasize the choices that a leader can make as illustrated at the bottom of page 114.

3. Inventions

   Devote the remainder of the period to reviewing students' responses to the invention tasks assigned on pages 113 and H-25.

4. Homework

   Students are to complete the excursion on pages H-26 to H-30.

THE WINDMILL PROBLEM

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Background reading. Students read pages 122 to 124.	LB-122 to 124	8-10
2. Getting started. Students work through the windmill problem in their groups according to the directions on page 125.	LB-125	30-40
{*optional break point*}		
3. Group reports *(optional)*. Groups give reports at the end of the period.	Poster paper and markers	15-30
4. Homework. Students read pages 130 to 135 in the Lesson Book.	LB-130 to 135	5

THE WINDMILL PROBLEM

GOALS:

To provide for practice in all the stages and methods of the excursion process;
To provide for practice in the group skills associated with the excursion process.

OBJECTIVES:

Students working in small groups will be able to conduct a complete analogy excursion with minimal guidance.

MATERIALS:

Lesson Books, notebooks, poster paper and magic markers.

PREPARATION:

Read the background pages on The Windmill Problem in the Lesson Book (pages 122-129). Students should have completed the excursion on pages H-26 to H-30.

DIRECTIONS:

1. Background reading

   a. Have students sit in their groups. Collect and review the homework assignment at this time if you wish.

   b. Have students read the statement of the problem and the background information on pages 122-124.

   c. Ask the class if they have any questions about the operation of windmills or about the problem they are asked to solve (the Cedars' problem outlined on page 122 and summarized on page 124).

2. Getting started

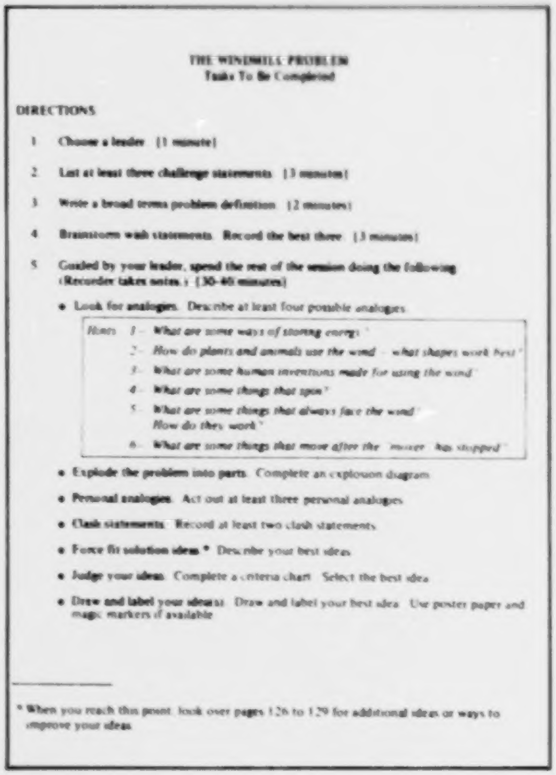
   a. Have the students read the directions on page 125. Clarify as necessary.

b. Have the groups select a leader and begin working on the problem.

The purpose of this session is to allow the groups to practice each of the excursion methods (see page 114). Accordingly, guide the class and/or individual groups as you see fit.

You may wish to interrupt the class or visit the groups after ten or so minutes have passed. They will probably get the most out of this lesson if they state the problem in the following way:

How might we generate electricity when the wind is not blowing?
AND
How might we design a windmill that would always face the wind?



THE WINDMILL PROBLEM
Tasks To Be Completed

DIRECTIONS

1 **Choose a leader. (1 minute)**

2 **List at least three challenge statements. (3 minutes)**

3 **Write a broad terms problem definition. (2 minutes)**

4 **Brainstorm wish statements. Record the best three. (3 minutes)**

5 **Guided by your leader, spend the rest of the session doing the following. (Recorder takes notes.) (30-40 minutes)**

- **Look for analogies.** Describe at least four possible analogies.

  Hints: 1 – What are some ways of storing energy?
  2 – How do plants and animals use the wind – what shapes work best?
  3 – What are some human inventions made for using the wind?
  4 – What are some things that spin?
  5 – What are some things that always face the wind? How do they work?
  6 – What are some things that move after the "mover" has stopped?

- **Explode the problem into parts.** Complete an explosion diagram.
- **Personal analogies.** Act out at least three personal analogies.
- **Clash statements.** Record at least two clash statements.
- **Force fit solution ideas.*** Describe your best ideas.
- **Judge your ideas.** Complete a criteria chart. Select the best idea.
- **Draw and label your idea(s).** Draw and label your best idea. Use poster paper and magic markers if available.

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* When you reach this point, look over pages 126 to 129 for additional ideas or ways to improve your ideas.

Note that pages 126-129 give strong hints for solution ideas. It is probably best to give students the opportunity to develop analogy ideas on their own before they see these pages. However, you may want to lead different groups to these pages at different times, depending on their progress.

3. Group reports *(optional)*

If you decide to extend this lesson to two days, the groups would have time to draw and label their ideas and present group reports at the end of the second session. The following is a suggested outline for the group reports:

a. Problem statement
b. Wish statements
c. Analogy ideas
d. Clash statements
e. Best idea
f. Explanation (or illustration) of how the idea would work.

Note: Students who are familiar with the operation of windmills may know immediately that a vane can be attached to the shaft that holds the propeller in order to keep the blades of the windmill facing into the wind. Students may also know that a battery (or batteries) is a common method of storing the energy produced by a windmill. If this occurs, encourage these students or groups to search for an alternative storage mode and/or a method of insuring that a windmill does not rotate too rapidly in high winds.

Among the ideas that have been suggested for constructing a continually responsive windmill are: a vane that operates like the rudder of an airplane; a windmill shaped like an eggbeater; a windmill shaped like a barrel with vents that rotate around a vertical shaft; a horizontal windmill that looks and works like an air-conditioning vent for an apartment house; multiple fixed windmills; and sails on a revolving track.

Solutions for the storage problem — the problem of maintaining a continual supply of electricity — include: a fly wheel; any kind of windmill-generated mechanical energy, as in the form of a spring, pendulum action, or an arrangement of pulleys and weights; compressed air; and water, either to increase the inertia of the blades or to serve as potential energy because of its height or temperature.

It may also be possible to combine solar power with wind power by constructing a trough-type collector that not only reflects the sun but funnels the wind into a turbine-type windmill. The assembly could rotate horizontally to track the sun and point the funnel into the wind.

4. Homework

Have students read pages 130-135. Collect and review the homework assignment for this session, H-26 to H-30, if you have not already done so. Give feedback as necessary.

VISTA I

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Setting the stage. Students select roles and problem statements.	LB-134 to 135	10-12
2. Excursions. Group leaders guide their groups on an excursion.	LB-137 LB-138 to 142	30-40
optional break point		
3. Presentations. Groups present their solution ideas.		10-15
4. Homework. There is no homework for the next session, which begins Unit IV.		2

VISTA I

GOALS:

To provide an opportunity for students to practice analogy excursions with minimal guidance.

OBJECTIVES:

Students will be able to complete an analogy excursion without guidance.

MATERIALS:

Lesson Books and notebooks.

PREPARATION:

Read pages 130-142 in the Lesson Book. Students should have read pages 130-135 in their Lesson Books.

DIRECTIONS:

1. Setting the stage

   a. Tell the students that they will have two class periods to design housing units for the Vista community. Each group will be conducting analogy excursions at both sessions and then presenting a group report with accompanying illustrations at the end of the second session.

   b. Have each group select an analogy leader, a recorder, and a reporter.

   c. Have each group select one of the problems (pages 134-135). Make sure that each group chooses a different problem. Ask them to re-read their problem, paying particular attention to the wish statement.

   Note that the five underlined sentences on pages 134 and 135 are wish statements. Each group should use one of the wish statements as a starting point for an analogy excursion but they should feel free to supplement this wish statement with one or more of their own at any time. In essence, the five problems are five aspects of the same problem — how to design an efficient, sef-sufficient housing unit.

   Note: If there is a student in the class who knows something about solar energy, it might be best to assign Problem V to his or her group.

d. While the groups are re-reading the problem statements, write the following directions on the board:

- *Follow the directions on page 137*
- *Leader conducts the excursion*
- *Recorder records the steps and ideas*

2. Excursions

a. Have the groups begin their excursions.

b. Circulate among the groups and offer help as you see fit. Encourage the search for analogies from nature, from other cultures and from other inventions. Encourage personal analogies, explosions and clash statements. Guide students to pages in their Lesson Books if and when they need clarification of the stages. Page 114 might be especially helpful.

c. When the groups are about halfway through the excursion process, suggest that they consult pages 138-142. These pages are designed to spur analogy ideas without giving away solutions. There is a page for each of the five problems.

PROBLEM I — It might be possible to: Build the housing unit into the side of a hill; place the unit half in and half out of the ground; have pop-up or revolving apartments within an underground unit; dig out a large maze of tunnels, rooms and open pits as in the homes of some burrowing animals; provide a view with a projector or periscope; reduce the outer wall area of an above-ground home; improve the insulation of an above-ground home.

Problem II — It might be possible to: Use some of the solutions from PROBLEM III; devise a way for the heat to change, shift or rotate panels, louvers or rollers from black to white; have an underlayer that tans like the skin (melanin) and changes the color or the reflecting property of the roof; cover the roof with different colored particles that have different expansion rates so that the light-colored particles cover the surface area when heated (cf. a flounder); cover a black roof with a liquid (e.g., wax) that would solidify and change color when heated; use a thermostat or light meter to trigger the color change.

PROBLEM III -- It might be possible to: Provide for a change in the angle of the roof or the panes of glass; use louvers or blinds; use light-sensitive tinted glass; restrict the light by using light-sensitive "cats eye" or camera lens panels; have one-way panes of glass that flip; devise a way for the glass to cover or immerse itself whenever the temperature rises; construct an internal cooling or heat-blocking device.

PROBLEM IV -- It might be possible to: Use a rock bin in the basement or a concrete wall covered with glass for storing heat; integrate water tanks within the living units (waterbeds, water floors); put waterbeds on the roof; build the house out of water barrels; build large south walls that both collect and store heat; put the greenhouse on the south wall; put water-filled pipes on the floor or underground beneath the greenhouse; store heat in the ground around the housing unit.

PROBLEM V - It might be possible to: Increase the effect of the sun's rays by using reflectors (mirrors, aluminum) to bounce the sun's rays from collector to collector; use bowl-shaped reflectors; make the entire roof (and/or walls) into a solar collector; expand the southern side of the unit; put the solar collector elsewhere; integrate the collectors with the greenhouse; extend the solar collectors up and out from the roof.

3. Presentations

   a. Allow 10-15 minutes for presentations.

   b. Give each group three to five minutes to complete its presentation.

   c. Encourage constructive questions.

   d. Ask each group to reconstruct how they generated their ideas.

4. Homework

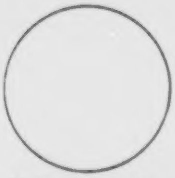
   There is no homework for the next session. Lesson 21 begins Unit IV. Students may wish to look ahead in their Lesson Books.

THINK OF TEN USES FOR:

A. USED RAZOR BLADES
B. OLD RAILROAD CARS
C. OLD REFRIGERATORS

Design a foolproof bicycle lock.

Design a cheap anti-theft alarm for bikes.

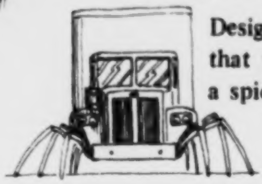


Using just three lines, cut this circle into eight parts.

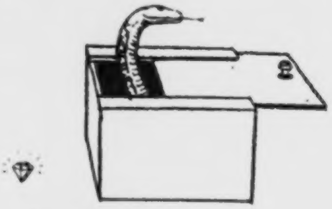
How could you use wave power to produce electricity?

DESIGN A TRAIN THAT NEVER STOPS

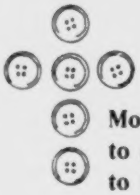
Design a supermarket without lines.



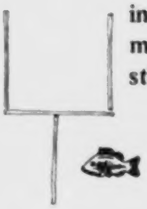
Design a truck that works like a spider.



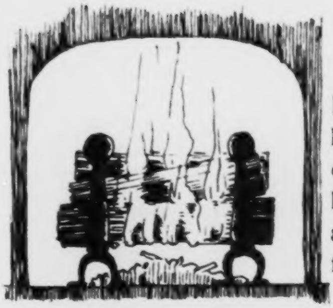
Suppose the diamond was inside the box with the poisonous snake. How could you get the diamond out of the box without using any tool or weapon?



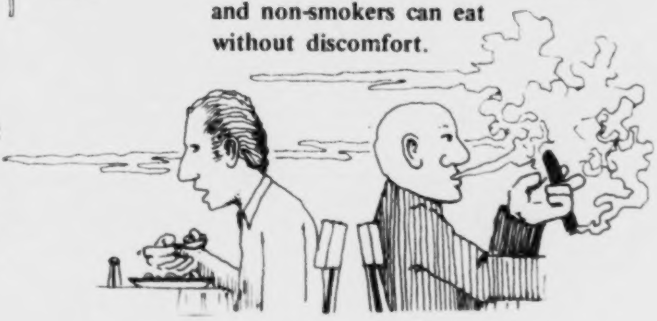
Move one button to another position to form two rows containing four buttons each.



Capture the fish inside the 'U' by moving just two sticks.



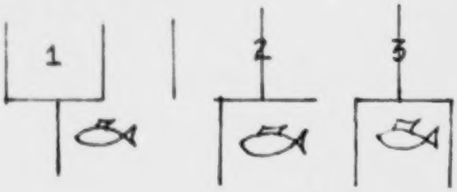
Design a house that could be heated by a single fireplace.



Design a restaurant where smokers and non-smokers can eat without discomfort.

Answers to the puzzles:

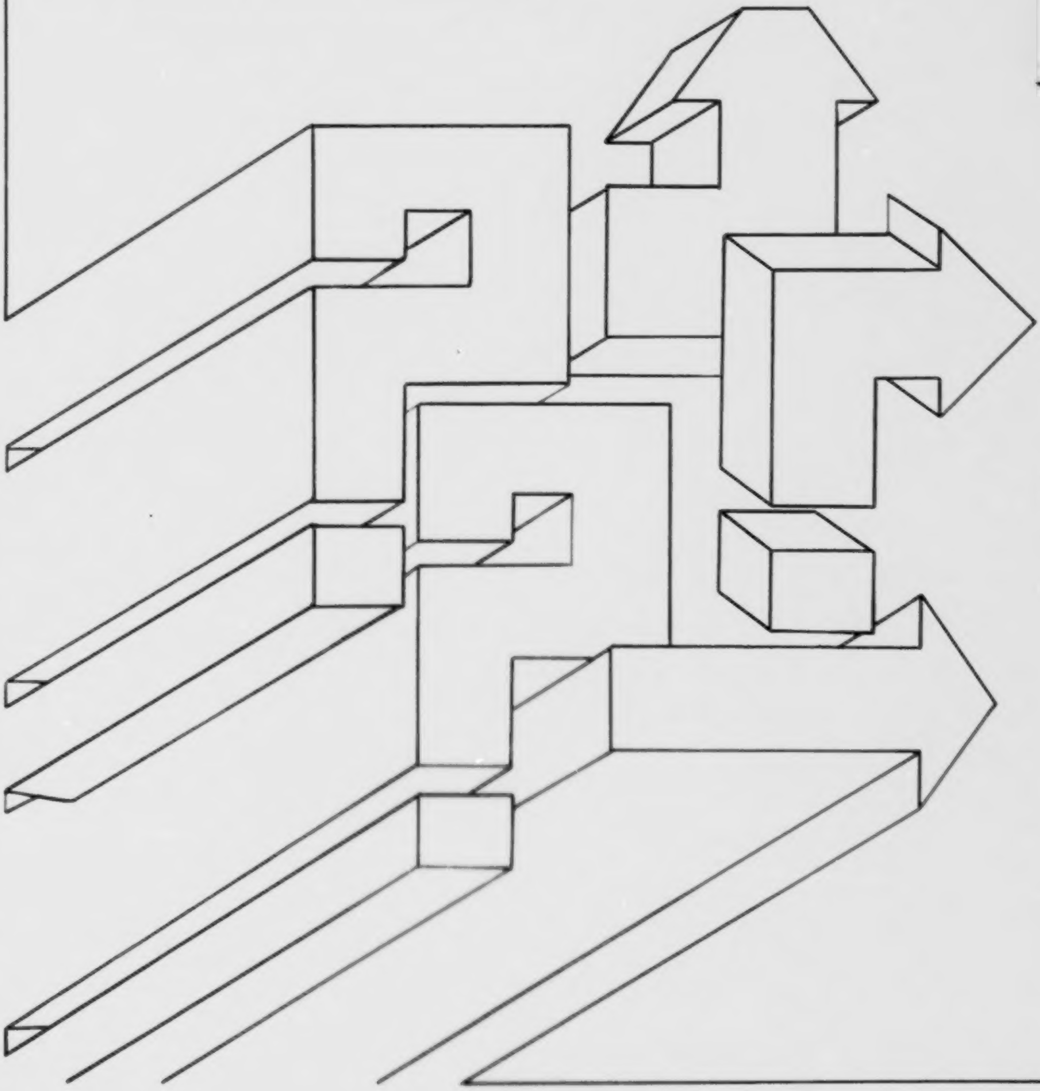
- **The circle problem.** The solution is easy once you see that the directions do not say three straight lines.
- **The buttons problem.** The solution is easy once you begin to think in three dimensions: Place the lower button in the verticle row on top of the center button.
- **The fish problem.** The solution is easy once you realize that a stick can "slide" as well as move.
- **The diamond problem.** The solution is easy once you realize that the box need not remain upright. Invert the box, open the lid slightly, and shake the box until the diamond rolls out.



(page 90 in Student Lesson Book)

MAKING CHANGES

a futures-oriented course in inventive problem solving

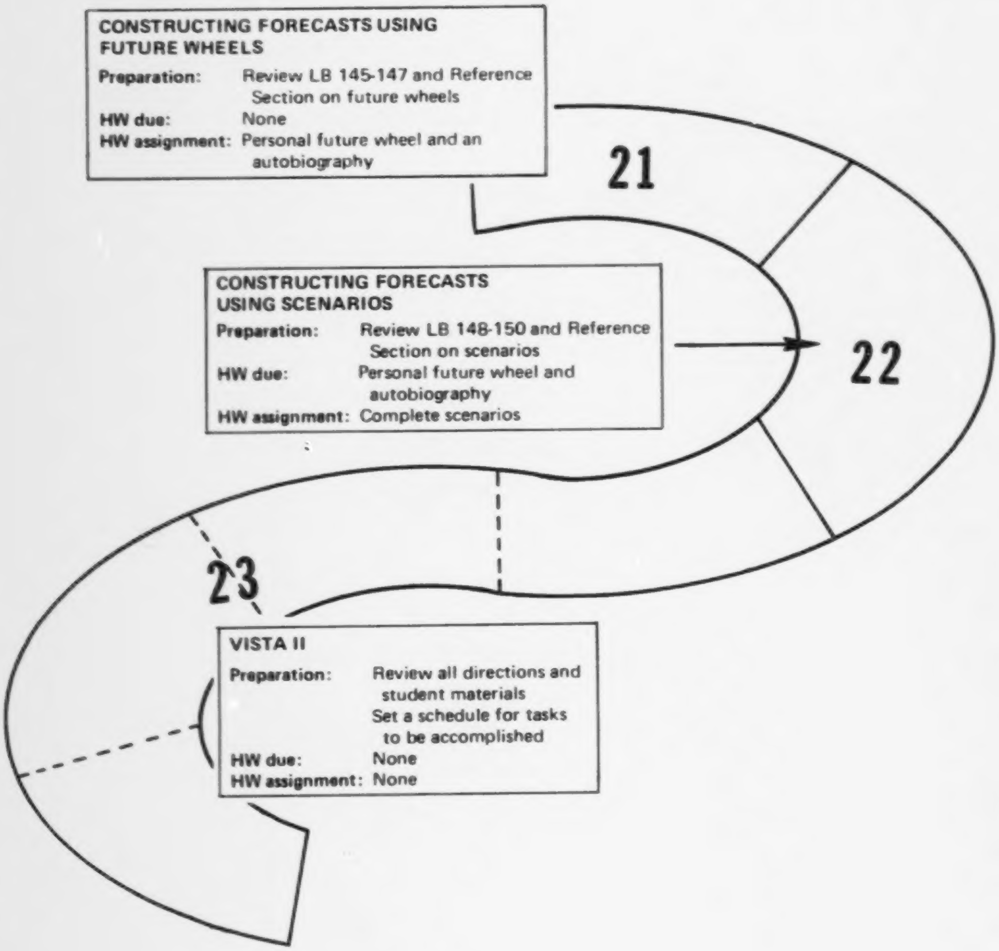


Unit IV

etc

CALENDAR AND HOMEWORK SUMMARY

UNIT IV



CONSTRUCTING FORECASTS USING FUTURE WHEELS

Preparation: Review LB 145-147 and Reference Section on future wheels
HW due: None
HW assignment: Personal future wheel and an autobiography

CONSTRUCTING FORECASTS USING SCENARIOS

Preparation: Review LB 148-150 and Reference Section on scenarios
HW due: Personal future wheel and autobiography
HW assignment: Complete scenarios

VISTA II

Preparation: Review all directions and student materials
Set a schedule for tasks to be accomplished
HW due: None
HW assignment: None

USING FUTURE WHEELS TO CONSTRUCT FORECASTS

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Introduction to future wheels. Teacher-led instruction on identifying needs and consequences of a given development.	LB-145	10-15
2. Group task. Students complete the task assigned on page 146 of the Lesson Book.	LB-146	15-20
3. Homework preparation. Students select a development from pages 146-147 by using three criteria.	LB-146 to 147	8-10
4. Homework. Students complete a personal future wheel. An autobiography is optional.		5

USING FUTURE WHEELS TO CONSTRUCT FORECASTS

GOALS:

To introduce the "future wheel";
To give students the opportunity to use a future wheel in order to determine needs and consequences of a given development.

OBJECTIVES:

Students will know the definition and function of the future wheel.
Students will be able to construct a future wheel from a given development and label needs and consequences generated.

MATERIALS:

Lesson Books and notebooks.

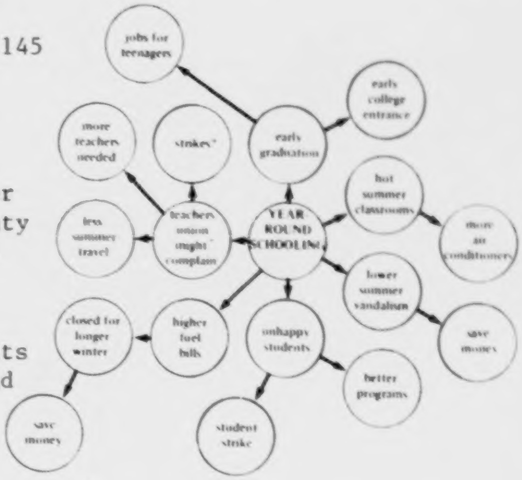
PREPARATION:

Read pages 145-147 in the Lesson Book and the section headed "Future Wheels" in the Reference Section.

DIRECTIONS:

1. Introduction to future wheels
    a. Ask students to read page 145 in their Lesson Books.
    b. Write *Future Wheel* on the board.
    c. Draw a circle in the center of the board, leaving plenty of space in all directions for other circles.
    d. Create a future wheel on the board by having students call out possible needs and consequences for the development "year-round schooling."

       You may want to point out that year-round schooling does not necessarily mean that vacations are eliminated.

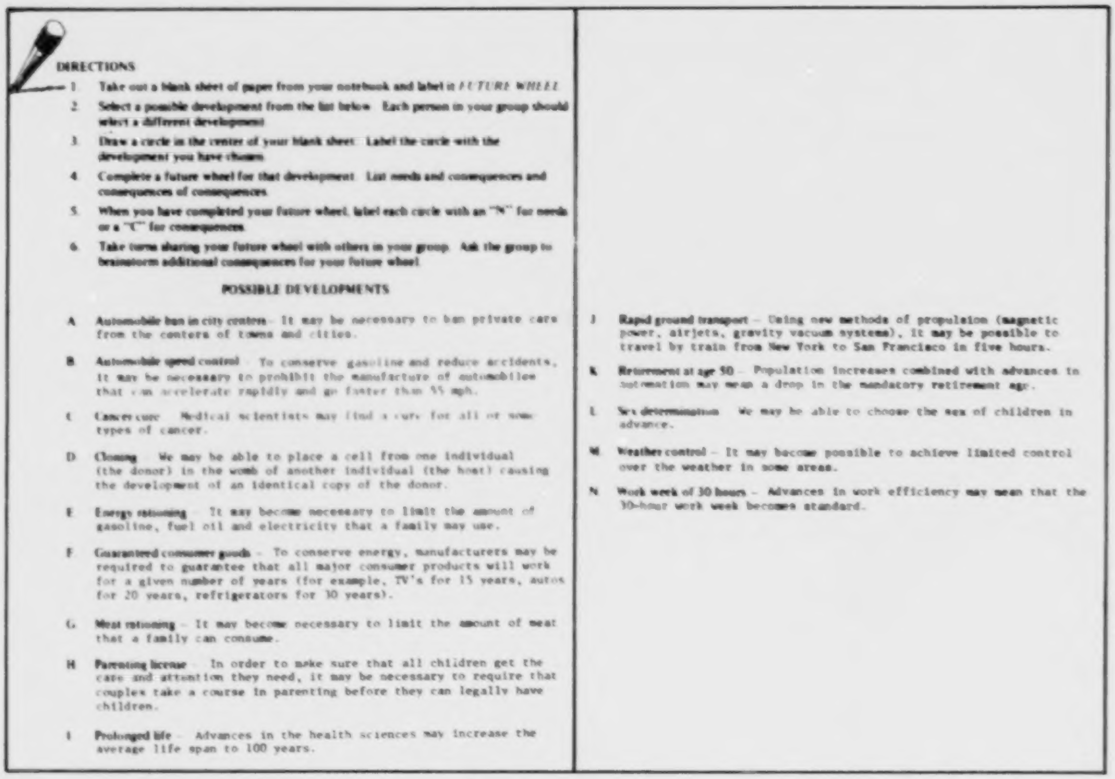

jobs for teenagers
early college entrance
more teachers needed
strikes?
early graduation
hot summer classrooms
less summer travel
teachers union might complain
YEAR ROUND SCHOOLING
more air conditioners
lower summer vandalism
closed for longer winter
higher fuel bills
unhappy students
save money
better programs
save money
student strike

2. Group task

   a. Have students read and follow the directions on page 146.

      You may want to have students read and discuss the possible developments on pages 146-147 before students make their selections.

   b. Help the groups get started with direction no. 6. Encourage a free flow of ideas. Some students may wish to expand their future wheels by adding the ideas suggested by others in the group.



DIRECTIONS

1. Take out a blank sheet of paper from your notebook and label it *FUTURE WHEEL*
2. Select a possible development from the list below. Each person in your group should select a different development.
3. Draw a circle in the center of your blank sheet. Label the circle with the development you have chosen.
4. Complete a future wheel for that development. List needs and consequences and consequences of consequences.
5. When you have completed your future wheel, label each circle with an "N" for needs or a "C" for consequences.
6. Take turns sharing your future wheel with others in your group. Ask the group to brainstorm additional consequences for your future wheel.

POSSIBLE DEVELOPMENTS

A **Automobile ban in city centers** – It may be necessary to ban private cars from the centers of towns and cities.

B **Automobile speed control** – To conserve gasoline and reduce accidents, it may be necessary to prohibit the manufacture of automobiles that can accelerate rapidly and go faster than 55 mph.

C **Cancer cure** – Medical scientists may find a cure for all or some types of cancer.

D **Cloning** – We may be able to place a cell from one individual (the donor) in the womb of another individual (the host) causing the development of an identical copy of the donor.

E **Energy rationing** – It may become necessary to limit the amount of gasoline, fuel oil and electricity that a family may use.

F **Guaranteed consumer goods** – To conserve energy, manufacturers may be required to guarantee that all major consumer products will work for a given number of years (for example, TV's for 15 years, autos for 20 years, refrigerators for 30 years).

G **Meat rationing** – It may become necessary to limit the amount of meat that a family can consume.

H **Parenting license** – In order to make sure that all children get the care and attention they need, it may be necessary to require that couples take a course in parenting before they can legally have children.

I **Prolonged life** – Advances in the health sciences may increase the average life span to 100 years.

J **Rapid ground transport** – Using new methods of propulsion (magnetic power, airjets, gravity vacuum systems), it may be possible to travel by train from New York to San Francisco in five hours.

K **Retirement at age 50** – Population increases combined with advances in automation may mean a drop in the mandatory retirement age.

L **Sex determination** – We may be able to choose the sex of children in advance.

M **Weather control** – It may become possible to achieve limited control over the weather in some areas.

N **Work week of 30 hours** – Advances in work efficiency may mean that the 30-hour work week becomes standard.

3. Homework preparation

   a. Write the following criteria on the board.

      1) *It will occur by the time I'm 30.*

      2) *I am in favor of it.*

      3) *It will affect my life.*

   b. Have each student select a development from the list on pages 146-147 that satisfies all three criteria (for them).

4. Homework

Note: You may want students to record this assignment in their notebooks.

Have students complete the following for homework:

1) A personal future wheel based on the development they just chose (all of the circles should be personal consequences or needs).
2) An autobiography *(optional)*. Ask students to pretend that they are 65 years old and are writing feature stories about themselves to appear in *Time Magazine*. Special consideration should be given to awards, contributions and achievements.

USING SCENARIOS TO CONSTRUCT FORECASTS

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Preparing for scenario writing. Students work as a class to construct an imaginative description of a common process as it might take place in the future.		15-20
2. Defining scenarios. Students read pages 148-149 in the Lesson Book and then suggest definitions.	LB-148 to 149	8-10
3. Writing a scenario. Students complete a scenario by following the directions in the Lesson Book.	LB-150	10-25
4. Homework. Students complete their scenarios for homework.		5

Unit IV
Lesson 22

USING SCENARIOS TO CONSTRUCT FORECASTS

GOALS:

To teach students how to construct a scenario.

OBJECTIVES:

Students will know what a scenario is and be able to describe alternate formats for a scenario.

Students will be able to write a scenario describing possible future events.

MATERIALS:

Lesson Books and notebooks.

PREPARATION:

Read the section headed "Scenarios" in the Reference Section and pages 148-150 in the Lesson Book. Students should have completed a personal future wheel and an autobiography *(optional)*.

DIRECTIONS:

1. Preparing for scenario writing

   a. Write on the board:

   Getting up and out in the morning.

   b. Ask students to "explode" this process by naming things that are part of most people's experience in preparing for work or school. They should name as many things as they can in a short period. Write ten or more on the board in chronological order. For example:

   hearing the alarm
   turning off the alarm
   getting out of bed
   making the bed
   showering/washing
   brushing teeth
   combing/brushing hair
   dressing
   preparing breakfast
   eating breakfast
   drinking coffee
   doing chores
   checking the weather
   checking the time
   locking the door
   catching the bus/train

   c. Now ask students to select one of the aspects on the board and brainstorm how "things might be different" in the year 2000. Again, encourage the rapid flow of imaginative ideas and hitchhikes from one idea to another.

d. Quickly ask for another selection and additional ideas.

e. Use the "Round Robin" technique to build an account of "getting up and out in the morning in the year 2000" (or 2100, 2500).

Round Robin: Telling the story in the first person, one student begins with a sentence such as "My pillow nudged my shoulder." Another student adds a sentence, e.g., "Since the pillow wasn't working too well that morning, I dozed off to sleep again." Students take turns, following one another as quickly as possible to complete the account.

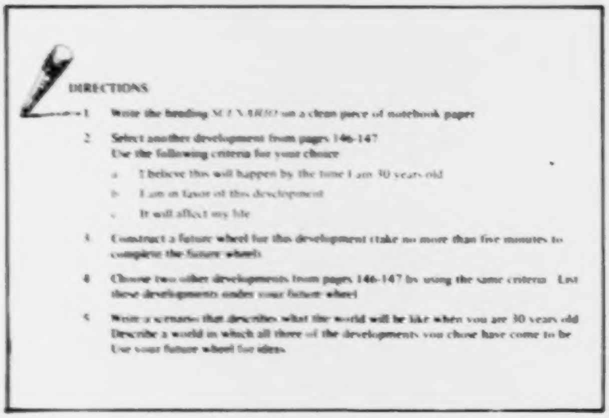
2. Defining scenarios

a. Have students read pages 148-149 in their Lesson Books.

b. When students have completed the reading, ask for a definition of a scenario. Write some of the key phrases from their definitions on the board.

c. Draw students' attention to the different types of scenarios described on page 149. Clarify as necessary. Remind students that the best scenarios are ones that tell how the world has changed and are both imaginative and detailed.

3. Writing a scenario



Have students read the directions on page 150 and use the remainder of the period to write their scenarios.

It may be interesting to have students share their ideas with other students in their group either in the middle of the task or at the end.

Find out how many students put themselves into the scenario. Survey the class to see how many students described how they might change and how the changing world might affect them. Encourage students to put themselves into their scenarios.

4. Homework

Have students complete their scenarios for homework.

VISTA II

Lesson Summary

Activity	Materials	Estimated Time (in minutes)
1. Homework review *(optional)*. Teacher-led review of students' scenarios.		15-20
2. Selecting a Senate. Teacher selects students to form the Vista Senate.		8-10
3. Getting started. Committee and reading assignments are made and teacher review of directions on pages 162-165 in the Lesson Book is conducted.	LB-151 to 161	10-12
4. Round One. Committee members use idea generation techniques to think of different uses for their invention, while Senate members construct a criteria chart.	LB-162 LB-164	20-25
optional break point		
5. Judging and awarding of points. Committees present their ideas to the Senate for judging and awarding of points.	LB-162 LB-164	10-15
6. Round Two. Committee and Senate members construct future wheels and scenarios to identify possible positive and negative consequences of the inventions.	LB-162 LB-164 and 165	20-25
optional break point		

VISTA II

Lesson Summary continued

Activity	Materials	Estimated Time (in minutes)
7. Judging and awarding of points. Committees present the results of their future wheels, scenarios, and cross-impact matrices to the Senate for judging and awarding of points.	LB-162 LB-164 and 165	10-15
8. Round Three. Committee and Senate members identify and define serious problems that might occur as a result of their development and use problem-solving strategies to think of solutions. *optional break point*	LB-163 LB-165	20-25
9. Judging and awarding of points. Committees report the results of their problem definition and solving activities to the Senate for judging and awarding of points.	LB-163 LB-165	15-20

VISTA II

GOALS:

To provide an opportunity for students to construct future wheels and scenarios;
To provide for the application of *Making Changes* strategies to future-focused social problems.

OBJECTIVES:

Students will be able to construct future wheels and scenarios with minimal guidance.

MATERIALS:

Lesson Books, notebooks, H-31 (Cross-Impact Matrix I) and H-32 (Cross-Impact Matrix II).

PREPARATION:

Read over all directions and student materials. Set a schedule for tasks to be accomplished.

DIRECTIONS:

1. Homework review *(optional)*

   Review the secnarios that students were to complete as homework for this session. Students could exchange scenarios or you might conduct a discussion. Since this lesson is a long one and has three break points, you may wish simply to collect the scenarios.

2. Selecting a Senate

   Vista II is a simulation. Four Committees (groups) will be competing for resources controlled by the Vista Senate. The Senate is required to make judgments about the quality and completeness of the presentations made by the groups on the three occasions. Since the responsibility of the Senate is to be judgmental, you may want to consider the following options:

   - Select one group to be the Senate. Select a group that would be able to handle the job of building a five-part criteria chart, be fair, and be quick to spot implications of presented ideas;

   OR

   - Staff the Senate by selecting students from the groups. Select three to five students for this task. Reassign students to groups so you are left with four equal-sized groups plus the Senate.

Note: If you decide that the second alternative is best or even if you choose the first, you may want students to select the combination of Committee assignment and invention that interests them the most. If so, you will have to allow five to ten minutes for students to read pages 151-161 and make their selections.

3. Getting started

   a. Decide which group becomes which Committee and make reading assignments as follows (see note above).

      - Senate — Read the information on all the Committees, pages 152-161.
      - Committee on the Environment (Telecommunicator) — Read pages 152-153.
      - Committee on Work (Robot Helpers) — Read pages 154-156.
      - Committee on Education (Socrates) — Read pages 157-159.
      - Committee on Health (Bio-Regulator) — Read pages 160-161.

   b. Review the directions on pages 162-165 with the class. It should be instructive for the Senate to read and hear the directions for the Committees and vice-versa.

   c. *(Optional)* At this time, you may wish to help students understand what they are about to do by asking them to consider the following analogy:

      Suppose the year was 1880 and you were called upon to make some judgments about two new inventions — the telephone and the automobile. Do you think that you would have been aware of the significance of these inventions at that time? Each invention has been put to thousands of uses since 1880 and each has had dramatic effects on American society. With a little imagination, many of the consequences of these two inventions could have been anticipated.

      To complete the warm-up, ask students to briefly generate ideas for the following questions:

      - What are some uses or applications for the telephone that were probably not anticipated in 1880?
        (E.g., weather reports, delivery service, trans-Atlantic cables, conference calls, opinion polls)
      - What are some new uses or applications for the automobile that were probably not anticipated in 1880?
        (E.g., race cars, taxi cabs, police cars, ambulances, auto trains)
      - What were some positive consequences resulting from the invention of the telephone?
        (E.g., immediate contact across large distances, immediate health care, expansion of businesses)

- What were some negative consequences resulting from the invention of the telephone?
  (E.g., increased noise, interference with the beauty of the countryside, less face to face contact)
- What were some positive consequences resulting from the invention of the automobile?
  (E.g., greater access to recreation, rural access to goods and services, more frequent visits among members of an extended family)
- What were some negative consequences resulting from the invention of the automobile?
  (E.g., increased pollution, "urban sprawl," increased accidents and injuries, decreased farmland and recreation land)
- What new ideas or inventions resulted from the impact of the telephone on the automobile and vice-versa?
  (E.g., automobile telephones, delivery service, curbside telephones, emergency road service telephones)
- What were some positive impacts of the telephone on the automobile and vice-versa?
  (E.g., better response to emergencies, increased access to goods and services, increased mobility, more variety of activities)
- What were some negative impacts of the telephone on the automobile and vice-versa?
  (E.g., less face-to-face contact, widened generation gap, increased spoilage of countryside)

4. Round One

   a. Have the Committee and Senate members read the directions for Round One in their Lesson Book and begin — page 162 for the Committees and page 164 for the Senate.

   b. Help the groups get started. Emphasize that the Committees' primary responsibilities are to think of new uses and new applications for their inventions.

   c. Meet with each group liaison. Clarify the special directions as needed. Point out that they are to adapt page H-31 to their purposes.

   Liaisons will probably find it easiest to consider the inventions two at a time. For each pair of inventions investigated (their own and one other), liaisons should consider new applications that might be possible if both inventions were to exist at the same time.

   d. Meet with the Senate. Point out that they are to have a criteria chart completed by the time the Committees are ready for their presentations. Offer your assistance.

If you aren't asked for assistance, you may want to check on the criteria chart being developed. Try to ensure that the chart includes some measure of how many ideas were presented, how good the ideas were, and how these ideas would benefit the people of Vista. Encourage the Senate to design a chart that is appropriate to their situation.

e. Remind the Committees that they will be judged on the number and quality of their ideas.

5. Judging and awarding of points

a. Have the Senate members move their desks to form a semi-circle facing the groups. Ask that one member of the Senate inform the Committee members of all the criteria by which their ideas will be judged.

b. Decide on the order of presentation of ideas and have the groups begin. Make sure that the results of the cross-impact matrices are reported.

c. Allow approximately five minutes for the Senate members to complete their criteria chart.

d. Have the Senate award points to the Committees. Ask that a critique of the Committees' presentations be given (i.e., how the Committees fared on the criteria chart) before the actual number of points awarded to each is announced.

6. Round Two

a. Have the Committee and Senate members read the directions for Round Two in their Lesson Books — page 162 for the Committees and pages 164-165 for the Senate.

b. Help the groups get started. Emphasize that the Committees' primary responsibilities are to identify positive consequences and ways of avoiding or dealing with negative consequences.

c. Meet briefly with the liaisons for each group. Clarify the special directions as needed. Point out that they are to adapt page H-32 to their purposes.

Liaisons will probably find it easiest to consider invention impacts two at a time. For each pair of inventions considered (their own and one other), liaisons should consider possible positive and negative impacts of one invention on the other as well as positive and negative consequences that might result from having both inventions existing at the same time.

d. Meet with the Senate. Point out that they are to complete a future wheel for each of the four inventions, as well as the cross-impact matrix on page H-32. Remind them that they also need to develop another criteria chart. Offer to assist them with this. Point out that they need to accomplish a lot in this round and that dividing the tasks among the members would be wise.

Again, it's a good idea to check on the criteria chart being developed. It should address the number and kind of consequences the Committees come up with and how well the members have taken the best interests of all Vista residents into account.

The Senate has the responsibility to cross-examine the Committees. In order to know what to ask each Committee, they will have to know as much about possible positive and negative consequences and impacts as the Committees do. The cross-impact matrix and the future wheel should be used to help the Senate ask questions like "Have you considered...?" or "What will you do about...?".

e. Remind the Committees that they will be judged on the number and kind of consequences they come up with.

7. Judging and awarding of points

a. Have the Senate arrange their desks in a semi-circle. Have one member inform the Committee members of all the criteria by which their ideas will be judged.

b. Decide on the order of presentation and have the groups begin. Make sure the results of the cross-impact matrices are reported.

c. Allow approximately five to ten minutes for the Senate members to complete their criteria charts.

d. Have the Senate award points to the Committees. Ask that they offer a critique of the presentations before the actual awarding of points.

8. Round Three

a. Have the Committee and Senate members read the directions for Round Three in their Lesson Books — page 163 for the Committees and page 165 for the Senate.

b. Help the groups get started.

Identifying manageable challenge statements will probably be difficult for the groups. You may wish to focus their thinking to some extent. One possibility is to focus their thinking on "How might we prevent...?". Another possibility is to ask them to generate some societal outcome they would most like to see in the future (crime reduction, better communication between generations, more productive use of leisure time, less racism, etc.), define that outcome as a challenge statement, and then attempt to generate ideas for how they could use their invention or combinations of inventions to bring about this positive state.

c. Meet briefly with the Senate. Point out that they are to construct another criteria chart, this time judging the presentations on the importance of the problems chosen and the quality of the solution ideas. Remind them that they are representing all Vista residents.

d. Remind the groups of the essential criteria by which their presentations will be judged.

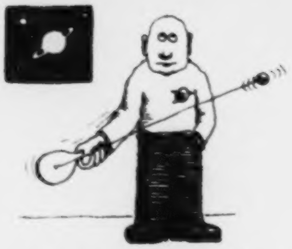
9. Judging and awarding of points

a. Have the Senate once again form a semi-circle with their desks. Have them inform the Committee members of the specific criteria which will be used to judge their presentations.

b. Decide on the order of presentation and have the groups begin.

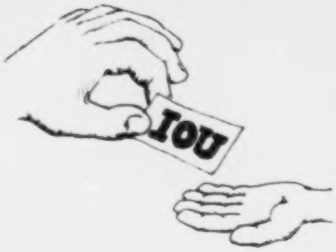
c. Allow approximately five to ten minutes for the Senate members to complete their criteria chart.

d. Have the Senate critique the presentations, award the final points, and announce the winner.



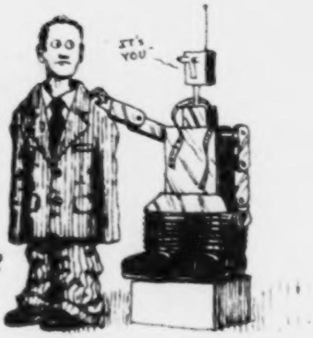
Design recreation activities for space station dwellers.

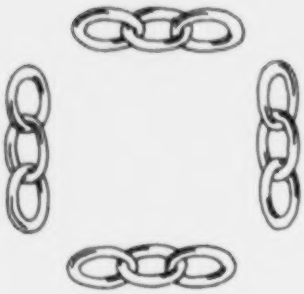
If we had a cashless society, would children still get an allowance?



DESIGN A WHEELCHAIR HOCKEY MATCH.

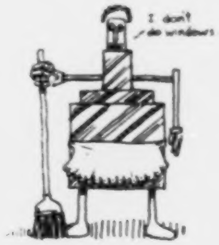
What might an automated clothing store look like?
What would an automated tailor look like?





A jeweler charges one dollar to break a link and one dollar to melt a link back together. In order to join the four corners into a necklace, the jeweler's bill was eight dollars.

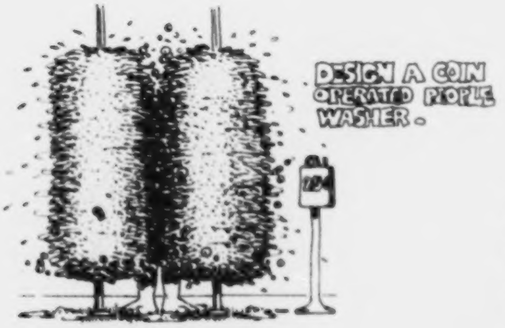
How could the jeweler have done the job for six dollars?



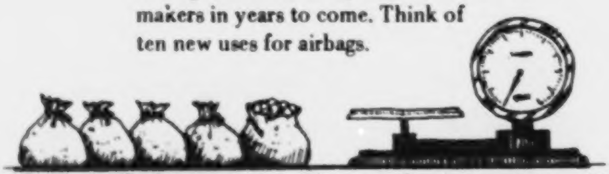
Draw a robot that would be capable of doing most household chores. How would it work? What would it be unable to do?

Illustrate a cheap method for lighting a city at night.

Airbags will be used by some automobile makers in years to come. Think of ten new uses for airbags.



DESIGN A COIN OPERATED PEOPLE WASHER.



You have five bags. Each bag contains 20 coins. One bag contains gold coins. The others are fake. The only way you can tell a gold coin from a fake coin is by weight [gold coins weigh 31 grams, fake coins weigh 30 grams].

How could you find the bag of gold coins by using the scale only one time?

Answers to the puzzles:

- **The links problem.** The solution is to break apart one of the four pieces shown in the illustration into three open links ($3). The total job would then cost $6.
- **The coin problem.** This is a difficult problem. The trick is to take one coin from one bag, two coins from the next bag, three coins from the next, four from the fourth and five from the fifth. Place all 15 coins on the balance. You know that if all the coins were gold, the weight would be 465 grams (15x31). So if the weight is off by one gram (464 grams), you know that bag #1 contains the fake coins. If the total weight is off by 2 grams, it's bag #2; if it's off by 3 grams, it's bag #3, and so on.

(page 91 in Student Lesson Book)

REFERENCE SECTION

Contents:

Groups R-1 to R-3
Idea Generation Techniques R-4 to R-10
Futures Studies R-11 to R-25
References R-26 to R-36

GROUPS

FORMING THE GROUPS

Students will be working in small groups throughout the *Making Changes* course. To a great extent, the success of the course depends upon the chemistry and productivity of these groups.

During Lesson 2, students are asked to fill out a Group Choice Form. This handout asks students to name three students with whom they would like to work. Sometime before Lesson 6, you will need to form groups based on your students' choices. The following guidelines were developed from research on group problem solving and results of field tests of the *Making Changes* program.

- *Students should not view the Group Choice Form as a popularity poll. They should be aware that they are choosing people with whom they can cooperate to solve problems and think of ideas.*
- *For most classes, groups composed of five or six students will work best. Larger groups are difficult to manage. Smaller groups may be handicapped by absences.*
- *A diversity of interests among group members increases the chance that a broad spectrum of ideas is presented. Forming groups composed of males and females is one way of insuring a diversity of interests.*
- *Students will contribute to a group and cooperate with others to the extent that they feel accepted by other group members. It is best to form groups made up of students who are (or will be) friendly toward one another.*
- *Group productivity will be greatly reduced if the group is made up of representatives of different sub-groups or cliques; if the group contains two or more students who reinforce each other's disruptive habits; or, if a group includes two natural leaders.*
- *It is desirable that each group have an equal opportunity for success. "Special" students (special in either positive or negative abilities or traits) should be distributed among the groups.*

CONSTRUCTING A MATRIX

1. Draw a matrix on a large piece of paper. This grid should have as many rows and columns as your class has students. List the students in alphabetical order down the left side (rows) and in the same order from left to right across the top (columns). The names in the rows are the "authors"; the names in the columns are the "choices" (see example on page R-3).

2. Taking each author Group Choice Form in alphabetical order, place an "X" in the column under each of his or her choices. Continue to fill out the matrix for all of the authors' forms.

3. Next to each author, note the sex and the hobby or interest given on the form.

4. Build groups by using the following steps: *These steps will not work faultlessly with all classes. However, you should not have a problem if you adhere to the "spirit" of the steps.*

   a. Determine the number of groups. The optimal group has five members. Depending upon your class size, you may have groups composed of five or six members.

   b. Deal with your least popular students first. *"Least popular" students have one or no X's in their columns; "most popular" have many X's in their columns.* Select as many "least popular" students as your class has groups (0's or 1's, but especially 0's). Write their names in a column on a separate sheet of paper.

   c. For each least popular student listed, locate the name on the author line and read across the matrix to find his or her one choice who is most popular as rated by the rest of the class. Pair that least popular student with the most popular choice. Continue until each of the least chosen students has a partner.

   d. With the highly popular students you have paired, locate their names on the author lists and read across the matrix to find their choices. Expand your existing groups by selecting new students who have been chosen by your highly popular students.

   e. You should now have five to six groups of two to four students each. Enlarge these groups by adding students who have chosen or have been chosen by the existing group members. Use the following criteria to expand your groups:

      - *mutuality*
      - *effecting an even sex ratio*
      - *variety of interests*

   f. Consider each group in turn. If you can answer each of the following questions affirmatively, that group should function well:

      - *Is each student working with at least one person of his or her choice?*
      - *Are both sexes included?*
      - *Is at least one member able to read well?*
      - *Are there between four and six students in the group?*
      - *Are the interests of the members varied?*

      If any question draws a negative response, reassign one member and check the affected groups again.

g. Again consider each group in turn. If you answer any of the questions below in the affirmative, you will probably need to reassign students:

- *Is this group made up of two complete and separate social cliques?*
- *Is there more than one leader? If so, will they be in conflict?*
- *Does the group include disruptive students that might best be split up?*

Note: If you have difficulty satisfying all the criteria above, you may wish or need to form one group of students of one sex.

h. The group rosters should now be final. You may wish to make copies of the group rosters to give to the groups.

EXAMPLE OF PART OF A GROUP MATRIX

AUTHOR / SEX	INTEREST	CHOICE							
		A	B	C	D	E	F	G	H
A/m	model making				X	X			X
B/f	sewing	X					X	X	
C/m	kites	X	X		X				
D/m	camping	X				X	X		
E/m	sports		X		X			X	
F/f	horses		X		X			X	
G/f	chess				X	X	X		
H/f	reading	X	X					X	

In this example, C and H are least popular; B, D, A, and G are popular.

Since C chose D, they become partners. H and B become partners. F chose and was chosen by D. A chose and was chosen by H.

So, Group 1 = (C, D, F) but they all have outdoor interests, so add G who chose D and was chosen by F.

Group 2 = (H, B, A) but they all have sedentary interests, so add E who chose B and was chosen by A.

IDEA GENERATION TECHNIQUES

INTRODUCTION

Can you teach people to produce better ideas? The answer is "yes, but not easily." Since all ideas, no matter how new and revolutionary they seem are merely combinations or reversals of old ideas, exposure to varieties of knowledge areas is crucial for training the creative individual. But knowledge alone is insufficient. The creative individual is not just well-read or smart. The creative individual knows *how* to think--strategies for combining parts of the problem, for calling up items from memory, for scanning possibilities that increase his or her chances of arriving at high quality creative solutions. *Making Changes*' concentration on those strategies is based not on the premise that all students can be trained to be "creative geniuses" but that *all* students' creative performance can be increased as a result of learning some simple techniques.

Each of the idea generation techniques introduced in the *Making Changes* program is presented below with a brief explanation of its origin. Variations or techniques are presented where appropriate. Note that it is far more important for students to appreciate the "spirit" of a technique such as the checklist than to be able to recall it precisely from memory.

BRAINSTORMING

Alex Osborn (1963) discovered in the 1930's that far more good ideas are produced when ideas are generated in an atmosphere where judgment is suspended than in a typical discussion or conference. For Osborn, the principle of *deferred judgment* was the key to the success of these freewheeling sessions which he dubbed brainstorming sessions. Since Osborn's time, brainstorming has captured the interest of problem-solving groups in business, industry and education. Brainstorming has been found to be a successful procedure on an individual as well as a group basis for increasing both the total number of ideas as well as the overall quality of ideas produced.

Each of the four brainstorming rules makes a separate and important contribution. Deferred judgment (no criticism) not only eliminates the damper that nay-saying can have on idea generation, but tends to produce more favorable attitudes toward one's own and others' ideas. In most instances, when people generate ideas, they will produce a small number of fairly common responses. Instructing brainstorming participants to think of wild and unusual ideas and to think of many, many ideas gives them permission to go beyond the responses they have stored in memory and forces them to think for themselves. Research on brainstorming groups has shown that the best ideas tend to be produced towards the bottom of the brainstorming list by participants who feel sufficiently comfortable to offer bizarre suggestions.

One of the commonly accepted definitions of the creative idea is that it is a new combination of previously unrelated ideas. Emphasizing the importance of looking for new combinations, as the final "hitchhiking" rule does, can significantly increase both the number and quality of ideas produced. Osborn found that over a large number of brainstorming sessions, about 30% of all the ideas produced could be traced to hitchhikes.

Variations on Brainstorming

- *Reverse Brainstorming*

  List all of the things wrong with an operation, product, process, or system.

  Take each flaw in turn and suggest a way of overcoming it.

- *Stop-Go Brainstorming*

  Alternate between brainstorming and evaluation.

  Stop every ten minutes to select the most promising avenue, then redirect the group's ideas in that direction.

- *The 1-6-1-6 Method*

  Alternate between individual and small group brainstorming. This method tends to produce a large number of ideas and, if individuals present their ideas to the group prior to a group session, the sessions usually take off in a flurry of hitchhikes.

FORCE FIT

Force fit is another technique that originated in a commercial setting. The force fit technique calls for forcing a relationship between two or more previously unrelated objects. Force fit can be used to generate possible new relationships between any combination of objects, systems, and processes. Multiple forced relationships can be generated for any pair of things, or single force fits can be produced for several items on a list.

Parnes (1967) points out that deliberately associating objects in a non-habitual way may result in new ideas and more importantly in a movement away from habit thinking—the tendency to see only habitual relationships between things in one's environment.

Variations on Force Fit

- *Noun-Verb Combinations*

  Start with two objects. Turn one of the words into a verb. Generate ideas.

- *Noun-Adjective Combinations*

  Make up a list of adjectives. Force fit each in turn on the object or thing that you would like to improve.

CHECKLISTS

An idea checklist is a handy or memorable list of "change words"—verbs that suggest different ways or processes of change—that can be used to spur ideas for a given problem. A checklist operates as a memory aid, like a shopping list, to insure that no possibility is ignored.

The checklists on pages 22 and 23 in the Lesson Book are adapted from Davis (1973) and, like brainstorming, can be traced back to Alex Osborn. Osborn called his checklist "Idea Spurring Questions."

Variations on the Checklist

- *Scamper*

  Substitute
  Combine
  Adapt
  Modify
  Put to other uses
  Eliminate
  Rearrange

  The Scamper checklist was developed by R.F. Eberle (in Parnes, Noller, and Biondi, 1977). Its principle advantage is the ease by which it can be recalled when needed.

- *Osborn's list* (1963)

  Put to other uses? (New ways to use as is? Other uses if modified?)
  Adapt? (What else is like this? What other ideas does this suggest?)
  Modify? (Change meaning, color, motion, sound, odor, taste, form, shape? Other changes?)
  Minify? (What to subtract? Eliminate? Smaller? Lighter? Slower? Split up? Less frequent?)
  Substitute? (Who else instead? Other place? Other times?)
  Rearrange? (Other layout? Other sequence? Change pace?)
  Reverse? (Opposites? Turn it backward? Turn it upside down? Turn it inside out?)
  Combine? (How about a blend, an assortment? Combine purposes? Combine ideas?)

PART-CHANGING METHOD

The part-changing method is adapted from Davis' work (1971) which in turn is an adaptation of the *attribute-listing* technique developed by R.P. Crawford (1968). Whereas the checklist leads you to consider ways to change an object or system as a whole, the part-changing method breaks the object or system into its component parts. Each part is then examined for possible changes. The part-changing method for years has been the method chosen by manufacturers interested in bringing out a "new" model that would make an old model obsolete.

Variations on the Part-Changing Method

- *Attribute Listing*

  Instead of naming the parts of the object, the attributes or qualities of an object are listed. Each attribute is then examined for possible changes, for example, in its:

  size
  shape
  color
  material
  texture
  opacity

  Note that only simple objects are limited to these attributes. Complex systems that have arrangements of parts require additional attributes.

- *Attribute X Parts*

  List the parts of whatever you wish to change down one column. List the attributes in a second column. Read across and propose changes. The ideal method is to look at all possible combinations of attributes and parts. See page H-5 for a diagram of how this can be done.

CHECKERBOARD

The checkerboard technique is an adaptation of the *morphological-synthesis* technique (Davis, 1971). In the checkerboard technique, two dimensions of the problem are identified. A dimension may be a part, an attribute, or a way of doing something. The two dimensions are then placed on a grid. For each dimension, a limited number of ideas is generated which become the rows and columns on the grid. Finally, all of the combinations of ideas on the grid are examined. Davis (1973) reports that the checkerboard was used by a class of sixth graders to generate ideas for short stories and to produce 2,016 new ice cream flavors.

Variations on the Checkerboard

- *The Catalog Technique*

  A large number of invention ideas can be generated through the use of a department store catalog. Select products at random. Place half of the list on one axis and half on the other. Search through the combinations for invention ideas.

ANALOGIES

The lessons on analogies in the *Making Changes* program are adapted from ideas and materials developed by Synectics, Inc., a corporation that helps companies solve problems and train problem-solving groups. Synectics is not an idea-generation technique. Rather, it is a process, a set of strategies and methods. The process concentrates on metaphorical thinking, especially analogies and metaphors drawn from nature. For example, Davis (1973) reports that "when faced with the problem of inventing a vapor-proof closure for space suits, one Synectic group imagined insects running up and down the closure manipulating little latches—a far-fetched idea which led to a workable air-tight zipper."

Variations on Synectics can be found in quantity in Gordon (1961, 1963) and Synectics, Inc. (1968). Here is an abbreviated version of the Synectics process taken from *An Introduction to Synectics* written by the *Synectics Education Systems* (1972). *Making Changes* equivalents for Synectic terminology are included where appropriate.

EXCURSION STEPS	*SESSION TRANSCRIPT*
1. PROBLEM AS GIVEN (PAG): The original statement of the problem is presented by the persons whose problem it is. (The Mess)	*Airport fires due to crash landings of planes present a great problem. Fire fighting apparatus cannot get there fast enough.*
2. ANALYSIS OF THE PAG: This analysis should be concrete and tough-minded. (Fact Finding)	*The first few seconds right after a crash are the critical ones. At present it is impossible to deliver fire fighting equipment in time to do the most good. Foam on the runway is effective but it requires time to prepare.*
3. PURGE IDEAS & CRITICISMS: The Purge is an opportunity to present and criticize ideas that have come to mind by now. These ideas are likely to be superficial, but they will free you to concentrate on the excursion process. (Get Rid of Old Ideas)	*Purge Idea--"Spot fire trucks strategically over the airport."* *Criticism--"So many fire trucks might interfere with the landing procedures."*

EXCURSION STEPS	*SESSION TRANSCRIPT*
4. *PROBLEM AS UNDERSTOOD (PAU): This is a simple statement of the essence of the PAG.* (Wish Statement)	*What is needed is apparatus that appears instantly whenever it is called for—like magic.*
5. *DIRECT ANALOGY (DA): This simple metaphorical form is a simple comparison between two things or concepts. Direct Analogy is the primary mechanism for developing new contexts in which to view the PAU.* (Look for Analogies)	*An EVOCATIVE QUESTION is a question that forces a metaphorical, rather than an analytical response.* *Evocative Question for a Direct Analogy—"What mechanical thing appears instantly whenever it is called for?"* *Direct Analogy Response--"An umbrella."*
6. *PERSONAL ANALOGY (PA): This Operational Mechanism is an empathic identification with an object or thing. The goal of a Personal Analogy is for you to become the thing—to imagine how you feel and how your body and muscles feel as the thing with which you are identifying.*	*Evocative Question for a Personal Analogy—"Imagine you are an umbrella that's just been opened in a driving rainstorm. How do you feel?"* *Personal Analogy Response—"My owner flips me open and I look around for rain to fight. That's my job, to strike back at the rain just as hard as it hits me. I've got to function like this because my skin is so thin that otherwise I'll get punctured."*
7. *COMPRESSED CONFLICT (CC): This form of metaphor is a poetic, two-word description on a high level of generality. The two words should seem to contradict and sometimes even fight each other.* (Clash Statement)	*Evocative Question for a Compressed Conflict—"Now let's take two conflicting aspects of the PA and put them together into a short phrase to describe the umbrella."* *Compresed Conflict Response—"DELICATE AGGRESSOR."*

EXCURSION STEPS	SESSION TRANSCRIPT
8. FINAL DIRECT ANALOGY: The purpose of a Synectics Excursion is to help you get away from your problem. Therefore, it is crucial that your Final Direct Analogy be more distanced and apparently less relevant to the problem than your first DA.	Evocative Question for a Final Direct Analogy—"From the biological world what is an example of 'delicate aggressor'?" Final Direct Analogy Response—"A frog's tongue. It is soft and delicate, but it shoots right out and grabs flying insects."
9. ANALYSIS OF THE ANALOGUE: You must unearth the underlying elements and functions of the Final Direct Analogy.	A frog has a long tongue which is kept curled in his mouth. The tongue "shoots" out like a New Year's Eve noisemaker.
10. FANTASY FORCE FIT (FFF): The descriptive framework of the Final Direct Analogy is used to view the Problem As Understood in a new context. Don't worry if your FFF is really fantastic. (Force Fit)	Evocative Question for a Fantasy Force Fit—"What if our airport fire fighting apparatus were giant frogs? How would they use their tongues to put out fires?" Fantasy Force Fit Response—"I see only one huge frog. It's sitting on the control tower and whenever there's a fire or crash, it shoots out its tongue and slaps out the fire with its wet tip."
11. PRACTICAL VIEWPOINT: This is the final step in a Synectics Problem-Solving Excursion. Now the metaphors, the fantasy, and all the apparently non-relevant material are used to see the problem in a way that is completely different from earlier views. And constructive alternatives are developed. (Force Fit)	Question for a Practical Viewpoint—"How can we use this huge frog to put out fires?" Practical Viewpoint Response—"I just concentrated on the tip of the frog's tongue and thought that we could have a gun, set on a tower, that would fire special cartridges containing foam. The whole airport could be divided into grids. When a crash occurs on a certain grid, this information is fed automatically into a computer which tells the gun where to fire."

FUTURES STUDIES

INTRODUCTION

> *Teachers from kindergarten to graduate school now are introducing the future into education. This movement to futurize education arises from a growing recognition that the extremely rapid pace of social and technological change means that the world of tomorrow--in which today's students will be adults--is going to be vastly different from the world of yesterday that schools have traditionally stressed.*
>
> (editorial comment in
> *The Futurist*, August 1974.)

The accelerating interest in futures studies, referred to by various authors as futuristics, futurism, futurology, forecasting and futures research, is in large measure attributable to the writings of Alvin Toffler. Toffler taught one of the first courses in futures studies in 1966 and his books, *Future Shock* and *Learning for Tomorrow*, have inspired other teachers from elementary to graduate school to institute courses on the future.

For Toffler and others, the argument for putting futures studies into the classroom centers on the rapidity of social and technological change. Preparing students to adapt to and cope with these changes requires that students learn not only information about the future but learn the habit of anticipating change as well. This theme is echoed by a host of futurists and educators. Whether they point to the knowledge explosion, the salience of world problems, the necessity to learn long-range planning or the importance of "global thinking," the need to effect fundamental changes in students' attitudes or orientation toward the future is universally emphasized.

Aside from the recent surge of interest in career education, schools have maintained a past-to-present orientation in most subject matter areas. Futures studies is seen by an increasing number of educators as at least a partial remedy for the discontinuities that seem to exist between the content and demands of the "school world" and the current and anticipated demands of the "real world." Not only do students tend to question the relevance of what they are required to learn in school, but they fail to see the relationship between what they are learning and what they will do when school is completed. From a student-centered perspective, futures studies may provide a vehicle for equipping students with what psychologiest refer to as a "future-focused role image." This role image is more than "what will I do when I grow up?" The image includes some notion of what the world might be like, what changes might occur and what personal changes might be required in order to adapt to these possible futures.

As with most new ideas in education, reaching agreement that something should be done is far easier than achieving consensus on goals and methods. Stock (1977), for example, surveyed 573 teachers who were involved in futures studies programs in 184 secondary schools. Goals across these programs were as broad as they were vague:

GOALS FOR FUTURES STUDIES PROGRAMS

Ranking of Suggested Goal Statements in Degree-of-Acceptance Categories

High Degree of Acceptance:

1. *To stimulate in students the ability to imagine and consider the implications of many alternative possible futures.*
2. *To help students to realize that the future depends to a great extent on what is happening in the present.*
3. *To enable students to realize the impact of technology on society.*
4. *To help students to realize how anticipated future changes may alter their own personal life-styles and aspirations.*
5. *To help students search for and identify future trends.*
6. *To strengthen students' practical ability to anticipate and adapt to change.*
7. *To help students develop the attitude that they can be actively involved in influencing their own future.*
8. *To help students to clarify and evaluate their own values and goals.*
9. *To help students to clarify and evaluate society's values and goals.*
10. *To help students understand the requirements for human survival.*
11. *To help students develop an understanding of mankind as a single human community.*
12. *To encourage students to commit themselves to action to improve present conditions in the world.*
13. *To develop in students the ability to integrate ideas and information originating in diverse disciplines.*

Moderate Degree of Acceptance:

14. *To help students develop an optimistic attitude toward the future.*
15. *To help students develop an understanding of the world as a single global system.*
16. *To enable and motivate students to share their futures studies knowledge and insights with others.*

17. *To help students develop human relations skills.*
18. *To give students an understanding of some of the basic concepts and methods employed by practicing futurists.*
19. *To help students appreciate the historic development and importance of human thought about the future.*

A focus on the future within the secondary school may take the form of a separate course, a unit of instruction within a course, or a broad unifying theme that runs across a number of subject matter areas. Likewise, there is considerable variety in the instructional approaches employed. "Futurizing" the curriculum may mean science fiction readings, topical studies such as ecology or genetics, simulated environments, or training in forecasting techniques. Futures studies is multidisciplinary in nature and can and has been integrated across curriculum areas. Thus, a math teacher may introduce trend extrapolation; a language arts teacher may involve students in writing scenarios; a social studies teacher may use environmental materials to investigate future uses of resources; a science teacher may invite experts to lecture on scientific and technological developments; a guidance counselor may run seminars on future careers and changes in employment.

Kauffman (1976) advocates a school-wide approach to future-oriented education. For Kauffman, such a program:

- *Begins with the student's own personal image of the future, working to strengthen it where necessary.*
- *Relates all subject matter to the future needs of the students.*
- *Apportions space in the curriculum to different subjects according to their relevance to the students' futures, explains the rationale for curriculum choices to students, and allows flexibility to accommodate differences in interests, ability, and future plans.*
- *Presents content in an interdisciplinary manner, emphasizing the underlying similarities of all living and social systems.*
- *Organizes the learning environment to stimulate creativity, self-motivated learning, and self-discovery.*
- *Emphasizes skills over knowledge, helping students learn "sciencing" as well as science, forecasting as well as forecasts—in short, thinking as well as facts.*

Despite the diversity of goals and emphases, there are at least two common threads that can be found in all futures studies programs: a focus on alternative futures and an understanding of forecasts and forecasting. Kauffman gives a succinct analysis of the assumptions behind these emphases in his chapter on the "alternative futures approach."

> - *The future which actually occurs will be determined partly by history and physical reality, partly by chance, and partly by human choice. The relationships among these factors will vary according to the amount of time one is looking ahead and the nature of the choices made.*
> - *At any given moment, therefore, there exists a range of alternative futures which might come about. History and physical reality determine which futures are in the range. Chance and human choice will determine which one of those possible futures will actually happen.*
> - *True "freedom of choice" only exists when one understands the full range of options available and the possible consequences of each option.*
> - *The purpose of futuristics, therefore, is not to predict the future, but rather to improve our understanding of the range of alternative futures which might come about and of the role that both chance and deliberate choice might play in either achieving or avoiding any particular future.*
>
> *Thus, to the futurist, "the future" is a zone of potentiality, rather than "that which is going to happen." Similarly, "knowledge about the future" is seen as knowledge about what is possible, rather than knowledge about what is certain. A statement about a future possibility (such as its likelihood, the things which would contribute to its happening, or the effect it would have on other events) is known as a forecast, and the process of discovering such information is called forecasting. Although many forecasting methods are in current use, none of them is self-sufficient. Instead, each can be called "the alternative futures approach" to forecasting.*

FORECASTING

Futurism has its roots in the writings and predictions of ancient historians, philosophers and prophets. Modern futurism can be characterized by a belief in the ability of humans to improve their condition through science and rational thought. According to Cornish (1977), modern futurism began with the utopian writings of Sir Thomas More and Sir Francis Bacon, and the belief in progress that began in the late seventeenth century.

Forecasting did not become a serious scientific activity until it was adopted by the U.S. military in the Cold War years following World War II. A concern for long-range military and defense plans gave rise to a concern for technological forecasting, the formation of the RAND Corporation and other "think tanks," and the development of new forecasting techniques such as the Delphi method and the scenario.

Since forecasting deals with events which have not yet taken place, it is an activity that is considered to be more art than science by some. Martino (1976) argues that even though there are no facts about or measurements of the future, forecasting can be every bit as scientific as the sciences of astrophysics or meteorology. Forecasters are concerned with patterns derived from past experience and with making inferences about the extent to which these patterns will contine in the future. According to Martino, the weakness and uncertainty characteristic of forecasts has more to do with the complexities of the areas being forecast than with the methods employed. For Martino, the ground that a forecaster stands on is no less solid than that of the experimental scientist.

Types of Forecasts*

There are two general types of forecasts, the exploratory forecast and the normative forecast. In exploratory forecasts, future developments are projected by examining past trends and cycles. Normative or goal-oriented forecasting starts with some desired end state and works backwards in order to plot ways that this future situation might come about.

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* The major portion of this section is taken from a two-part article by Martino (1976, 1977) entitled "Survey of Forecasting Methods." For the purpose of completeness, each of the methods covered by Martino will be mentioned below. Detailed descriptions are provided for those methods which have potential application for supplementing and improving the *Making Changes* lessons.

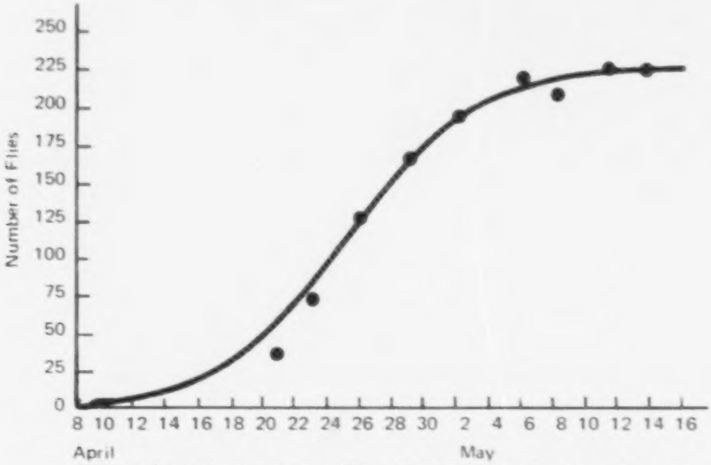
Exploratory forecasting is done through extrapolation. An historical pattern is identified and extended into the future. Extrapolation can be based on the assumption of no change in a particular pattern or on the assumption that some kind of interaction with other patterns will occur. Martino (1976) identifies three major categories of exploratory forecasting: (1) purely extrapolative methods, (2) explanatory methods, and (3) auxiliary methods.

A. Exploratory Forecasts

1. Purely Extrapolative Methods

a. Growth curves. Many biological phenomena and some technological developments exhibit S-shaped curves characterized by slow growth in the beginning, then a period of rapid growth, followed by a plateau as the upper limit to growth is approached.

Growth curves are commonly used to describe population growth. Many of these curves forecast limitless and catastrophic increases in the human population. Salk (1977) describes the signaling mechanism inherent in fruit flies that tells them at a given point that it is time to stop multiplying exponentially.



Growth of fruit-fly population. From *The Biology of Population Growth*, by Raymond Pearl.

According to Salk, the human population may have that same built-in feedback mechanism. At some point the human population will begin to level off in much the same way as has been observed with lower species.

b. Trend curves. Trend curves are used to plot the long-term behavior of a subject area. Trend curves often consist of a summary or compilation of growth curves plotted over time.

Kauffman (1976) lists twelve questions that can be used to guide the examination of trend curves.

- *What are the underlying causes which created the trend in the past?*
- *How stable are those conditions likely to be in the future?*
- *What new developments are necessary for the continuation of the trend?*
- *What new developments might alter it?*
- *Is the trend approaching some saturation point or limit?*
- *Does it conflict with some other trend?*
- *Does the trend benefit government, business, or other interest groups, and will they (can they) support the trend if it falters?*
- *Does the trend have potentially harmful consequences or side effects?*
- *Are there likely to be deliberate efforts to halt or alter the trend?*
- *How easily can the trend be halted and how long would this take?*
- *How much time is likely to elapse between the appearance of a problem and the point at which the problem becomes a crisis?*
- *If the trend does not continue, what are the most likely alternatives?*

2. Explanatory Methods

a. Correlation methods. Clues to the future of a particular topic or quantity can be uncovered by examining some other more easily measurable factor with which it is related. Changes in the economy are signaled by "leading indicators," for example. Changes in school enrollment can be estimated by looking at changes in the birth rate.

b. Precursors. Precursors are events that warn of a change in related areas. The Arab oil embargo was a precursor of higher oil prices, energy conservation and research into new kinds of energy resources. A medical breakthrough may be a precursor for changes in the death rate, employment patterns, and welfare payments.

c. Systems dynamics models. When most of the important factors influencing change, as well as all the important interactions among these factors are known, causal models can be constructed that simulate the universe of factors involved. Models are usually mathematical in nature and are often computerized. The "limits to growth" model is an example of a computerized systems dynamics model. Despite their complexity, models of this sort are still basically extrapolative. They assume that factors important in the past will continue to be the important factors in the future.

3. Auxiliary Methods

a. Cross-impact matrices. The cross-impact matrix is a relatively new method. It was first used in the late 1960's as an aid in making defense and transportation decisions.

In its simplest form, a series of forecasted events are listed as both the rows and columns of a matrix or grid. The cells of the matrix represent the interactions between the events. In essence, the cross-impact matrix is an accounting system--a way of insuring that all possible interactions of a series of events, trends, or developments are examined.

The examination of the cross impacts related to two events (A and B) can yield the following kinds of data:

- a description of the effect of A upon B.
- a description of the effect of B upon A.
- a description of the multiple effect given A plus B.
- an expression of the relative value of the interaction.
- an awareness of an inconsistency inherent in the interaction.

b. Scenarios. According to Kahn and Wiener (1967), scenarios are "hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision points. They answer two kinds of questions: (1) Precisely how might some hypothetical situation come about, step by step? and (2) What alternatives exist, for each actor, at each step, for preventing, diverting, or facilitating the process?"

Strictly speaking, scenarios are not forecasts. Scenarios, like cross-impact matrices, are a means of linking forecasts together. Although not as rigorous as a matrix, a scenario can be quite useful for revealing details, especially consequences and inconsistencies, given a set of forecasts.

In their book, *The Year 2000*, Kahn and Wiener summarize the advantages of the scenario technique:

> *The scenario is particularly suited to dealing with events taken together—integrating several aspects of a situation more or less simultaneously... Some of the advantages of the scenario as an aid to thinking are:*
>
> - *They serve to call attention to the larger range of possibilities that must be considered in the analysis of the future. They dramatize and illustrate the possibilities they focus on.*
> - *They force the analyst to deal with details and dynamics that he might easily avoid treating if he restricted himself to abstract consideration.*
> - *They help to illuminate the interaction of psychological, social, economic, cultural, political and military factors.*
> - *They can illustrate...certain principles, issues or questions.*
> - *They may also be used to consider alternative possible outcomes of certain real past and present events, such as Suez, Lebanon, Laos, or Berlin.*
> - *They can be used as artificial 'case histories' and 'historical anecdotes.'*

Scenarios may take a variety of forms. Scenarios may describe a hypothetical chronology or events as written from the present, or they may be written as if the writer is in the future looking backward. Alternative scenarios may be written to assist in the examination of options. Relatedly, "worst of all possible worlds" scenarios can be compared to "best of all possible worlds" scenarios. "Surprise-free projections" are special kinds of scenarios that assume no change in well-established historical patterns such as population or gross national product. Scenarios can be used in conjunction with other techniques, as when a single cell of a cross-impact matrix is explored with a scenario. Finally, scenarios have a good deal of dramatic value and can be used to illustrate a moral position or issue, as was done in Rachel Carson's *Silent Spring*.

B. Normative Models

Martino (1976) identifies three types of normative forecasting: (1) morphological models, (2) relevance trees, and (3) mission flow diagrams.

1. Morphological Models*

Major elements of a discrete situation are identified, then represented in a chart as a hierarchical system of alternatives. Here is an example of a morphological model offered by Martino (1977):

MASS TRANSIT SYSTEM

SCHEDULE

historic
responsive
real-time

ROUTES

Guideways	Usage
fixed	*exclusive*
flexible	*shared*
none	*general*

VEHICLES

Size	Power	Control Type	Control Location
5 passengers	*diesel*	*manual*	*internal*
30 passengers	*steam*	*semi-automatic*	*external*
100 passengers	*battery*	*automatic*	
	turbine		
	external		

The table above contains a total of 3x5x3x2x3x3x3 or 2,430 possible types of mass transit systems. By eliminating the impossibilities and inspecting the remaining alternatives, a normative forecast can be constructed.

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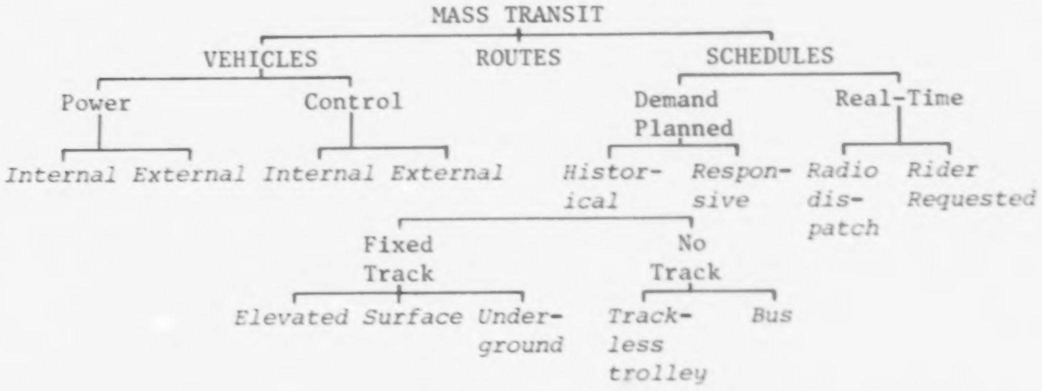
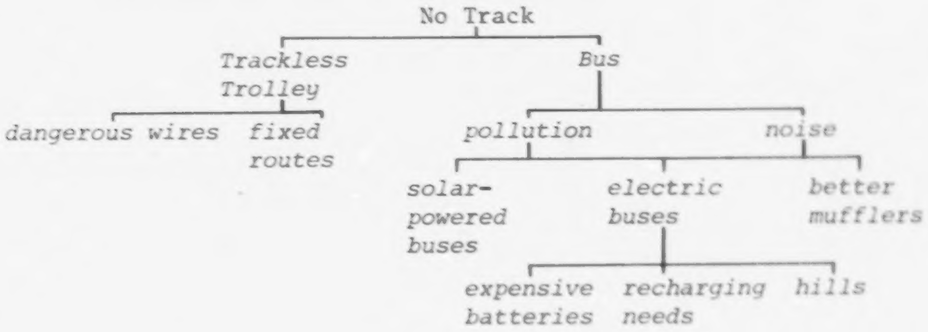
* Note that a morphological model has much in common with the part-changing and checkerboard technique from Unit I. It should be possible for students to construct diagrams like this for any area of interest. The diagram can then be treated as if it were a checkerboard to generate new alternatives for the future.

2. Relevance Trees*

Relevance trees are quite similar to morphological models. A situation is subdivided into smaller and smaller units with the relationship between units included as branches of a tree. Here is Martino's model of mass transit alternatives as examined by a relevance tree:


MASS TRANSIT
VEHICLES
ROUTES
SCHEDULES
Power
Control
Demand Planned
Real-Time
Internal
External
Internal
External
Historical
Responsive
Radio dispatch
Rider Requested
Fixed Track
No Track
Elevated
Surface
Underground
Trackless trolley
Bus

Relevance trees can be constructed as pure problem trees, pure solution trees, or mixed trees. Mixed problem-solution trees are most common. Here is an example of a mixed tree for one branch of the mass transit diagram:


No Track
Trackless Trolley
Bus
dangerous wires
fixed routes
pollution
noise
solar-powered buses
electric buses
better mufflers
expensive batteries
recharging needs
hills

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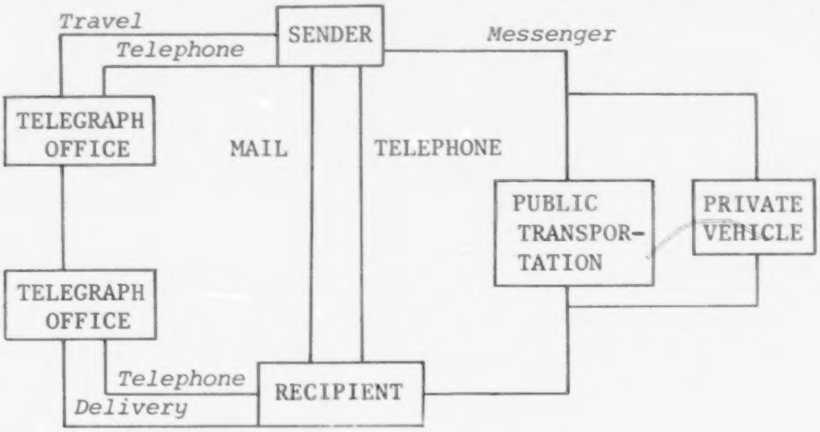
* Relevance trees can be used in conjunction with brainstorming to identify problems or explore possible alternatives.

3. Mission Flow Diagrams*

Normative forecasts can be constructed by diagramming all of the routes or processes involved in some function. Each route can be examined for advantages and disadvantages. New routes can be constructed. Problems with old and new routes can be identified and solutions generated. Here is a mission flow diagram showing alternative routes for transmitting a message:


Travel
Telephone
SENDER
Messenger
TELEGRAPH OFFICE
MAIL
TELEPHONE
PUBLIC TRANSPORTATION
PRIVATE VEHICLE
TELEGRAPH OFFICE
Telephone
Delivery
RECIPIENT

C. Other Methods

1. Delphi

In ancient Greece, the city of Delphi was known for its temple of Apollo where the Delphic Oracle was consulted for advice on the future.

The Delphi technique was developed by Olaf Helmer and Norman Dalkey of the RAND Corporation in 1964. In 1967, Helmer and Dalkey used the Delphi forecasting technique for the first time in industrial planning. Since that time the technique has been used in a variety of areas, including education, energy, community development, and business. In *Long Range Forecasting*, a paper delivered at the Conference on Forecasting the Future in 1970, Helmer describes the Delphi technique:

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* The mission flow diagram can be used in conjunction with the checklist and analogy excursions for improving any process or operation.

> *It eliminates committee activity among the experts and replaces it with a carefully designed program of sequential individual interrogations (usually conducted through questionnaires and occasionally through interviews) interspersed with information feedback on the opinions expressed by other participants in previous rounds... The Delphi process, in addition to exploiting the effect of the sheer size of the group, attempts to enhance the information flow among the participants by having them exchange opinions anonymously through an intermediary, with the result that group judgments derived through this process tend to be significantly more reliable than group judgments obtained through more conventional methods.*

The Delphi technique has been badly misused apparently because would-be forecasters have treated it as a universal method for predicting the future and have not clearly understood its purpose, its advantages and its disadvantages.

Kauffman, in *Teaching the Future* (1976), points out that the Delphi is a poll and, like any poll, its purpose is to identify the consensus of opinion of a group. It should *not* be used if the consensus can be determined more easily by a review of the literature. It should *not* be used in the middle of a controversy. It should *not* be used if a large percentage of the experts asked to respond cannot or will not participate. According to Kauffman, "The place where Delphi shines most, however, may be as an educational device and as an intragroup communication device."

2. Computer Simulations

   Manual methods for constructing forecasts can be quite time consuming and subject to error. The large number of variables inherent in causal models can easily result in important interactions being overlooked. Computer simulations provide the necessary speed and precision while providing a memory bank upon which subsequent changes in policy and in variables can be tested.

3. Future Wheels

   Future wheels are a diagrammatic way of making notes for a scenario. Although not a forecasting method, a future wheel is an excellent method for examining consequences, identifying problems and generating alternative paths (normative forecasts). According to Glenn and Guy (1974) who described the educational uses of future wheels in an article in *The Futurist:*

> *A future wheel begins with a circle drawn in the center of any piece of paper. Within the circle, each student writes down a subject that interests him, or the class as a whole. The subject can be an event, trend or idea--anything that the students want to know more about.*
>
> *Next, each student extends a number of spokes from the central circle on his piece of paper. He makes each spoke end in a possible result or association of the initial idea. The process is then continued to examine third and fourth order consequences of the germinal thought.*
>
> *This is an excellent technique for multi-concept formation and an aid for brainstorming. Such a visual package of information is also a guide for associative reasoning, anticipatory awareness and adaptation.*

The future wheel is a very easy technique to use. The vast number of ideas that come to mind given an influential development or event makes it a fertile technique for identifying levels or chains of consequences. Here is an example of a chain of consequences from Cornish (1977):

THE HIDDEN EFFECTS OF TECHNOLOGY

Automobile

- First-order consequences: *People have a means of traveling rapidly, easily, cheaply, privately door-to-door.*
- Second-order consequences: *People patronize stores at greater distances from their homes. These are generally bigger stores that have large clienteles.*
- Third-order consequences: *Residents of a community do not meet each other so often and therefore do not get to know each other so well.*
- Fourth-order consequences: *Strangers to each other, community members find it difficult to unite to deal with common problems. Individuals find themselves increasingly isolated and alienated from their neighbors.*
- Fifth-order consequences: *Isolated from their neighbors, members of a family depend more on each other for satisfaction of most of their psychological needs.*
- Sixth-order consequences: *When spouses are unable to meet heavy psychological demands that each make on the other, frustration occurs. This may lead to divorce.*

SUMMARY

The essence of forecasting can be described as "systems thinking" combined with controlled imagination. Good forecasting is, of course, accurate forecasting. Accuracy in forecasting takes critical thinking--being able to distinguish reliable from unreliable data and being aware of the universe of related trends and their interactions. But, in a very important sense, the most productive forecasts are not those that foretell what will be but rather point to what could be. Being able to describe and outline paths to alternative futures takes imagination as well as logical reasoning. The methods described above are tools designed to inform the imagination while opening up the linear processes of reasoning to new and different alternatives.

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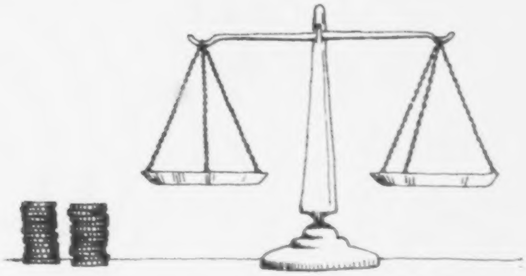
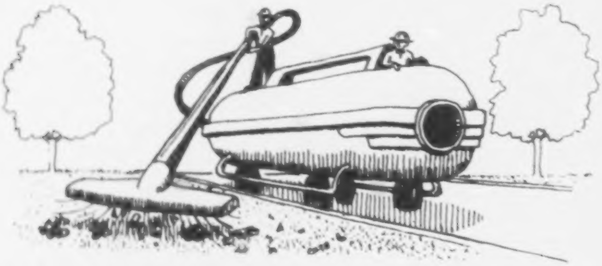
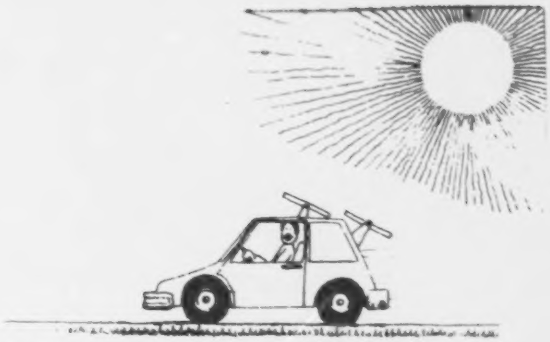


You have 24 coins. One coin is slightly heavier than the other 23 which all weigh the same. Your job is to figure out how to find the heavier coin by using the balance. The balance can be used to weigh any two sets of coins. How could you find the heavy coin by using the balance only three times?

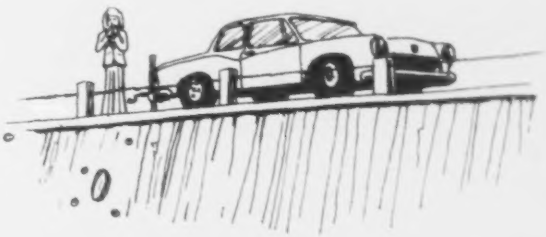


It costs 500 million dollars each year to pick up litter along roads and highways. Design a machine that could pick up roadside litter without leaving the roadway.

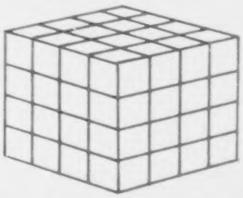
Low-strength laser beams can pass through the human body without injuring the patient. By increasing the power of the laser, diseased tissue such as tumors can be removed (burned) without surgery. However, to do this, the beams would have to be so strong that other tissue in their path would be burned. How could you use laser beams to burn a tumor without harming other tissue?



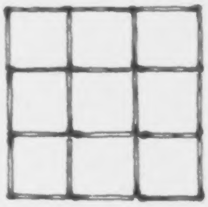
If there were solar-powered vehicles, how could you recharge the batteries with solar power at night?



Alice got a flat tire on a cliffside road ten miles from the nearest town. After she put the spare on, she accidentally kicked the four lug nuts over the cliff. [Lug nuts are used to attach the wheel to the car.] There are no other cars on the road and no buildings nearby. How could Alice get her car safely to town?



If all six sides of this cube were painted red, how many cubes would have 3 red sides, 2 red sides, 1 red side, no red sides?



Remove eight matches so that you leave only two squares.

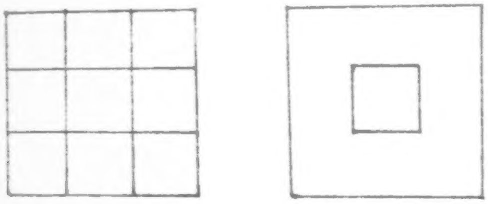
Answers to the puzzles: (see adjoining page 165)

(page 143 in Student Lesson Book)

Answers to puzzles on adjoining page 164

(and on page 143 in Student Lesson Book)

- **The lug nuts problem.** The solution to this problem is easy if you ask yourself, "Where can I get some lug nuts?" Although a car cannot be moved if a wheel has no lug nuts, it *can* be moved with only three lug nuts on a wheel. Remove a lug nut from each of the other three wheels.
- **The laser problem.** The solution to this problem is easy if you think of using more than one laser aimed in more than one way. For example, if you were to use three low-strength lasers focused on a single spot from three very different angles, the intensity at the spot where the angles meet would be three times as strong as the strength of any one of the lasers, and there would be no risk of damaging the tissues in the path of the beams.
- **The cube problem.** There are 64 small cubes in the large cube (4x4x4). All of the corner cubes would have three painted sides (8); all of the cubes between corners would have two painted surfaces (24); all of the remaining visible cubes would have one painted side (four to a side or 24); and all of the remaining interior cubes would have no painted sides (8).
- **The matches problem.** This problem is similar to the four triangles problem. Remove all of the interior matches except the ones that make up the center square.



- **The coin problem.** The trick is to divide the coins into *three* stacks each time. First, divide the coins into three stacks of eight. Compare the weights of two of the three stacks. Either one of these two stacks will be heavier than the other or they will be of equal weight. If they are of equal weight, then you know that the third, unweighed stack contains the heavy coin. Next, divide the eight coins from the heavier stack into three stacks of 3, 3, and 2. Compare the two stacks of three coins. Again, either one stack of three will be heavier than the other, or they will be of equal weight, in which case, you would know that the heavier coin is one of two coins in the leftover stack. If one of the stacks of three is heavier than the other, repeat the process by comparing the weight of any two of its coins.

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